# THE PHILIPPINE JOURNAL OF SCIENCE

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## CONTENTS

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# THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 17 JULY, 1920 No. 1


## PROCEEDINGS OF THE JOINT ANNUAL MEETING OF THE PHILIPPINE ISLANDS MEDICAL ASSOCIATION AND THE MANILA MEDICAL SOCIETY, HELD AT THE AMPHITHEATER OF THE COLLEGE OF MEDICINE AND SURGERY, FEBRUARY 2, 3, 4, AND 5, 1920

### MINUTES OF THE ANNUAL BUSINESS MEETING OF THE PHILIPPINE ISLANDS MEDICAL ASSOCIATION HELD FEBRUARY 5, 1920

The meeting was called to order by Pres. Harry [illegible] at 3.35 p. m., after the close of the last scientific session [illegible] February 5, 1920.

1. The minutes of the last meeting of the Association held June 12, 1919, were read and approved.

2. The chair appointed Drs. Calderon, de la Paz, and A. Garcia, a Committee on nomination for the annual election of officers of the Association.

3. The report of the Secretary-Treasurer of the Philippine Islands Medical Association was received. This report was entirely negative as there were no moneys received and no expenditures made.

4. Reports of the Standing Committee were called:

*a.* The report of the Scientific Committee was rendered by Dr. Stafford, the Chairman. It was embodied in the program of the Association rendered.

*b.* The report of the Committee of Public Policy and Legislation was rendered by Dr. Angeles, Chairman. It consisted of the resolution to be presented to the Legislature regarding the petition for legislation prohibiting advanced pregnant women from engaging in work and professional engagements and providing for them proper nourishment. On motion of Dr.

Wade, it was decided to take up this resolution with other similar topics under the heading of new business.

*c*. Report of the Committee of Publication rendered by Dr. A. Garcia. It consisted in the satisfactory negotiations with the Director of the Bureau of Science regarding the issue of one separate pamphlet embodying the proceedings of the Annual meeting and the publication of the different papers in a regular number of the Philippine Journal of Science, all under the same arrangement between the Manila Medical Society and that Journal.

*d*. The Committee on arrangements rendered a report of progress, though the Chairman stated that it was not yet possible to render a complete report due to still unfinished arrangements.

All these reports were approved.

5. Unfinished business:

*a*. The letter of the Secretary of the American Society for the Control of Cancer regarding a Cancer Committee in the Islands was read and the Chairman appointed Drs. Wade, Schöbl, and Gomez, Cancer Committee of the Association.

*b*. The letter of the Secretary of the V Asamblea Regional inviting coöperation of the Philippine Islands Medical Association was also read, and it was decided to give this Association's support.

*c*. The establishment of provincial branch societies was discussed. A committee composed of Drs. Calderon, de la Paz, Wade, and the Director of the Philippine Health Service was appointed to study the possibilities of the problem.

6. Dr. Saito of Japan requested permission of the Chair to read a paper on coöperation with the Far Eastern Association for Tropical Medicine. On motion of Dr. Wade, it was decided to let the Japan Medical Association take the initiative and that our Society will afterwards coöperate.

7. Dr. de la Paz, chairman of the Nominating Committee reported nominations as follows:

| | |
|---|---|
| For President: | Dr. H. E. Stafford. |
| For 1st Vice-President: | Dr. Carmelo Reyes. |
| For 2d Vice-President: | Dr. Otto Schöbl. |
| For Councilor for five years: | Dr. Liborio Gomez. |

On motion of Dr. Wade it was decided to cast the unanimous ballot of the Society for the names submitted by the Committee, and they were declared duly elected.

8. New business.

On motion of Dr. Garcia it was decided to express the Association's vote of thanks to all the entities and individuals who contributed with scientific articles and exhibited products at the meeting; also to those nonmembers who contributed papers for the scientific program, and to the Dean of the College of Medicine and Surgery for the use of the Hall.

9. Adjournment was approved, 4.30 p. m.

ARTURO GARCIA,
*Secretary-Treasurer,*
*Philippine Islands Medical Association.*

The following resolutions were offered and a copy of each was sent to the Governor-General, to the President of the Philippine Senate, and to the Speaker of the House of Representatives.

### RESOLUTION RECOMMENDING THE ESTABLISHMENT OF REGIONAL GENERAL HOSPITALS IN THE PHILIPPINE ISLANDS

WHEREAS, it is the belief of the Philippine Islands Medical Association, that one of the most effective measures that can be established for the preservation of life and improvement of health, in the Philippines, and particularly that of children is the establishment at selected provincial points, of general hospitals. These should be provided with special equipment for the clinical and laboratory examination of children and for their care when sick, about which the activities of the Philippine Health Service, La Liga Nacional para la Protección de la Primera Infancia and other entities may center; therefore be it,

RESOLVED, that the Philippine Islands Medical Association heartily endorse the plan proposed by Dr. Fernando Calderon for the establishment of eight such hospitals in the islands, and be it further,

RESOLVED, that the Philippine Legislature be respectfully urged to provide funds necessary for the carrying out of such a plan.

The above resolution was passed by the Philippine Islands Medical Association at its Annual Meeting, February 5, 1920.

ARTURO GARCIA,
*Secretary-Treasurer,*
*Philippine Islands Medical Association.*

### RESOLUTION RECOMMENDING THE CREATION OF A SEPARATE DEPARTMENT OF HEALTH AND CHARITIES IN THE GOVERNMENT OF THE PHILIPPINE ISLANDS

WHEREAS, it is the sense of the Philippine Islands Medical Association and the Manila Medical Society in joint meeting assembled, that the present conditions of the government activities pertaining to health, sanitation and charities involve duplication of labor and expense as well as hinder the efficiency thru the fact that the said agencies concerned in these activities are dispersed over at least three different departments;

WHEREAS, one department under one Cabinet Head who being a medical man and one particularly acquainted with all the needs and principles involved in the proper management of the various agencies of a modern health administration could bring about as near ideal coördination and efficiency as possible in this most important branch of government as far as national progress and development of the entire country is concerned;

WHEREAS, it appears, that this step would be in accordance with modern ideals of health and welfare service as demonstrated by institutions of similar character either already existing or recently innovated in other progressive countries such as England, Canada and Egypt, therefore be it,

RESOLVED, that the Philippine Islands Medical Association and the Manila Medical Society recommend to the Philippine Legislature that the necessary steps be taken tending to secure the establishment of a separate Department of Health and Charities, which would exert full control over all branches and divisions of government pertaining to health sanitation hospitals and charities which are now scattered over various government departments.

The above resolution was passed by the Philippine Islands Medical Association and the Manila Medical Society at their joint Annual Meeting, February 5, 1920.

ARTURO GARCIA,
*Secretary-Treasurer,*
*Philippine Islands Medical Association.*

## RESOLUTION RECOMMENDING THE ESTABLISHMENT OF NEW SEPARATE INSULAR HOSPITALS FOR DANGEROUS COMMUNICABLE DISEASES AND FOR INSANE AND CHRONIC INVALIDS IN THE CITY OF MANILA

WHEREAS, it is the sense of the Philippine Islands Medical Association that the present conditions at the San Lazaro Hospital are unsatisfactory, in that;

1. In spite of the recent addition of one new building to the Department for Contagious Diseases, the provisions for cases of such diseases, are still inadequate for the emergencies that may arise in time of epidemics;

2. The Insane and those ill of dangerous communicable diseases, are housed in close proximity with the result that the former are continually excited by the activities inside and outside of the hospital and the latter are unduly annoyed by the noises made by the insane;

3. The Insane and the old chronic invalids who are permanently confined there, are exposed to infection, and furthermore their maintenance at San Lazaro is an unnecessary duplication of labor and expense inasmuch as the City of Manila is already maintaining separate similar institutions with which these sections of San Lazaro Hospital could very well be combined;

4. One building and a portion of the grounds are occupied by the College of Veterinary Science for the corrals and hospital for the treatment of diseases of animals;

5. The facilities for the proper care of the dead, for the performance of postmortem examination and for the carrying on of many laboratory tests necessary for diagnosis and control of treatment are inadequate;

6. The present site of San Lazaro Hospital is undesirable and unsuitable for either an infectious hospital or an asylum for the insane, because of its location in a section of town which is bound to become a congested residential or business section of Manila, as already evidenced by the existence of two large schools in its vicinity, and the opening and proposed extension of Avenida Rizal;

WHEREAS, these conditions are not only undesirable in themselves but cause the public to be strongly prejudiced against the institution with resulting active antagonism to the enforcement of measures of isolation so necessary for the control of epidemics of dangerous communicable diseases, therefore be it

RESOLVED: That the Philippine Legislature be petitioned to authorize the sale of the property of San Lazaro Hospital and thereby secure sufficient funds to establish one asylum wherein the Insular and City Asylums for the Insane and Chronic invalids may be taken care of, and separate from this, a modern hospital for dangerous communicable diseases in some more suitable location, the size of said hospital, to be commensurate with the increasing population of Manila and vicinity; and in case that such a sale may not be practicable, that funds be provided for the erection of one modern hospital for cases of dangerous communicable diseases in another locality, consolidating and combining in the present San Lazaro Hospital the City and Insular Asylums for insane and chronic invalids, and removing the Hospital of the Veterinary College elsewhere.

The above resolution was passed by the Philippine Islands Medical Association at its Annual Meeting of February 5, 1920.

ARTURO GARCIA,
*Secretary-Treasurer,*
*Philippine Islands Medical Association.*

A further resolution was offered, a copy of which was sent to the Mayor of the City of Manila, and another copy to the Chief of Police, as follows:

### RESOLUTION INDORSING THE ENFORCEMENT OF THE SPITTING LAW AND RECOMMENDING IMPROVEMENT OF THE SPRINKLING OF STREETS OF THE CITY OF MANILA

WHEREAS, promiscuous spitting is not only extremely offensive, but is a most important means of spread of numerous infections of the respiratory tract, the most important of which is pulmonary tuberculosis, therefore be it

RESOLVED, that the Philippine Islands Medical Association heartily endorses the recent efforts of the Department of Police of the City of Manila to enforce existing laws respecting this nuisance and urges that the campaign be continued, and all efforts be made to improve the street sprinkling service in Manila, and be it further

RESOLVED, that the Philippine Islands Medical Association recommends that a special, active, and sustained educational campaign be undertaken by the Philippine Health Service in this connection.

The above resolution was passed by the Philippine Islands Medical Association at its Annual Meeting, February 5, 1920.

ARTURO GARCIA,
*Secretary-Treasurer,*
*Philippine Islands Medical Association.*

## SCIENTIFIC PROGRAM

The following is a list of the papers that were read and discussed, many of which are here reproduced in toto. Where a title is marked with *, it indicates that the paper is not reproduced; where a title is marked with * *, it indicates that the paper has been published in a previous issue of the Philippine Journal of Science.

### MONDAY, FEBRUARY 2, 1920, 4.15 P. M.

#### COLLEGE OF MEDICINE AND SURGERY

* Opening Address, by His Excellency Francis Burton Harrison, Governor-General of the Philippine Islands.
The Military Surgeon and the Civilian Practitioner, by Col. W. B. Banister, Medical Corps, U. S. Army.
* Presidential Address, by Dr. Harry E. Stafford, President, Philippine Islands Medical Association.

### TUESDAY, FEBRUARY 3, 1920, MORNING SESSION, 9.00 A. M.

#### COLLEGE OF MEDICINE AND SURGERY

Obstetrics and its Relation to Infantile Mortality, by Dr. Calderon.
Clinical Analysis of One Hundred Cases of Enterocolitis with Especial Reference to Edema, Dehydration, and Putrid Odor of Stools, by Drs. Albert and Horilleno.
** Some Observations on Intestinal Parasites Found in Filipino Children, by Prof. Haughwout and Dr. Horilleno.
* Clinico-Pathological Conference, by Drs. Sison and Wade.

### AFTERNOON SESSION, 2.00 P. M.

#### COLLEGE OF MEDICINE AND SURGERY

* The Present Status of Anti-Cholera Vaccination, by Drs. Bantug, Schöbl, and Gabriel.
The Complement Fixation Test for Syphilis: Incubation for Fixation at Ice-box Temperatures, by First Lieut. Joseph W. Smith, Jr., Medical Corps, U. S. Army.
Diphtheria in the Philippine Islands, by Drs. Gomez, Kapauan, and Gavino.
The Physician and the Laboratory, by Maj. J. E. Ash, Medical Corps, U. S. Army.
Note on the Keeping Qualities of Dried and Pulverized Vaccine Virus, by Dr. Schöbl.
Venom of the Philippine Cobra (Alupong) Naja naja philippinensis, by Drs. Monserrat, Schöbl, and Guerrero.

WEDNESDAY, FEBRUARY 4, 1920, MORNING SESSION, 8.00 A. M.

PHILIPPINE GENERAL HOSPITAL

* Radium Conference, by Dr. Fernandez.
* Surgical Clinics, by Drs. Guazon and staff.

AFTERNOON SESSION, 2.00 P. M.

COLLEGE OF MEDICINE AND SURGERY

* The First Hours of a Wounded Soldier in the Great War, by Dr. Basilio J. Valdez.
Clinical Forms of Panophthalmitis Observed in the Philippine General Hospital, by Dr. Ubaldo.
* Infant Mortality of the City of Manila during the Last Four Years, by Dr. Arenas, Philippine Health Service.
Corneal Paracentesis, by Dr. Velarde.
* Epidemiologic Problems in the Mountain Province, by Dr. G. Intengan, Philippine Health Service.
* New Ideas in Public Health, by Dr. Laygo, Philippine Health Service.

THURSDAY, FEBRUARY 5, 1920, MORNING SESSION, 9.00 A. M.

COLLEGE OF MEDICINE AND SURGERY

A Case of Pollakiuria immediately relieved by External Liberation of the Pelvic and Iliac Portions of the Ureter, by Dr. Eduque.
Informal Presentation of two Urological Cases: One a Diverticulum of the Bladder and One a Left Renal Calculus Complicated by Pyelitis, by Capt. Ivy A. Pelzman, Medical Corps, U. S. Army.
* Report of a Case of Actinomycosis of the Lungs, by Dr. Hilario.
Streptococcus Hemolyticus: a Case Study, by First Lieut. Harry G. Johnson, Medical Corps, U. S. Army.
* Lysis of the Œsophagus, with Intrapleural Hæmorrhage, In Streptococcus Septicemia, by Dr. Wade.
* Frequency of the Presence of the Cholera Vibrio in the Bile of Cholera Patients, by Dr. Tobillo, Philippine Health Service.
Clinical Studies on Encephalitis Lethargica, by Drs. Lantin and Vitug.

AFTERNOON SESSION, 2.00 P. M.

COLLEGE OF MEDICINE AND SURGERY

Xerophthalmia in Fowls Fed on Polished Rice and its clinical importance, by Drs. Guerrero and Concepcion.
The Dunham Fan in Roentgenograms, by First Lieut. Paul S. Seabold, Medical Corps, U. S. Army.
The Disease-Carrier Problem in the Philippine Islands, by Dr. Concha Brillantes.
Auto-infection, So-called, during the Puerperium, by Dr. Rustia.
Pathological Findings in three Cases of Encephalitis Lethargica, by Dr. W. de Leon.

BUSINESS MEETING, BANQUET, 7.30 P. M.

* Closing Address, by Dr. Fernando Calderon, President, Manila Medical Society.

MEMBERS

Abuel, José
Acosta-Sison, H.
Afable, V.
Albert, J.
Alberto, S.
Alejandrino, P.
Alvarez, José
Andaya, J. V.
Angeles, S. de los
Arenas, Felipe
Arnaldo, C.
Arvisu, T.
Avellana, J.
Avila, J. E.
Baltazar, M.
Baltazar, Martin
Banks, C. S.
Bantug, J. P.
Basa, Carmelo
Basaca, M.
Bautista, Ariston
Becher, Max A.
Benedicto, C.
Bringas, E.
Bulatao, E.
Calderon, F.
Cañizares, M.
Castillo, José
Castro, J. Luis de
Chavez, H. L.
Concepcion, A.
Concepcion, I.
Concha, A.
Consing, Cornelio
Cortes, J. D.
Cosca, Severo
Crowell, B. C.
Deles, C. H.
Domingo, E.
Dudley, F. W.
Dycaico, J.
Eduque, José
Elicaño, T.
Esquivel, F.
Esteban, B.
Estrada, J.
Fabella, José
Farrales, G.
Favis, G. F.
Fernandez, A.
Fernandez, R.
Fernandez de Leon
Filoteo, C.
Fitzbutler, J. H.
Franco, Cecilio
Gamboa, Luis
Garcia, Arturo
Garcia, Faustino
Garcia, Macaria
Garcia, Paciano
Gemil, M.
Gomez, Liborio
Gonzaga, J.
Gonzalez, Jesus
Guazon, P. C.
Guerrero, L. E.
Guevara, Romulo
Gutierrez, P.
Haughwout, F. G.
Hernando, E.
Hilario, J. S.
Hocson, F.
Horilleno, Fé
Hunt, H. L.
Jesus, V. de
Jugueta, D.
Katigbak, J. M.
Kee, Tee Han
Kneedler, H. D.
Lantin, P.
Lara, Casimiro
Lara, Florencio
Lara, Hilario
Laygo, Pacifico
Leiva, Lamberto
Lejano, A. L.
Lemmon, Waldo
Leon, Walfrido de
Lewis, J. W.
Leynes, Ricardo
Lucero, V.
Manalang, C.
Mandanas, A.
McVean, W. A.
Mendoza, G. P. M.
Monserrat, C.
Montes, José
Moreta, R. Ma.
Nañagas, J. C.
Nicolas, Felisa

MEMBERS—continued.

Norris, Claud E.
Ongsiaco, Ramon
Ordonez, L.
Orosa, Sixto Y.
Pañganiban, B.
Panis, E. M.
Parish, Rebecca
Pascual, Anicio
Paz, Daniel de la
Peñaflor, C. T.
Phelan, H. du R.
Pond, A.
Ramirez, M.
Reyes, C.
Rodriguez, P. A.
Rosario, S. V. del
Roxas, B.
Rustia, G.
Ruth, Chas. E.
Saleeby, A. M.
Saleeby, N. M.
Samson, B.
Sta. Ana, C. L.
Santos, I. de
Schöbl, Otto
Sevilla, V.
Siasoco, S.
Silva, B.
Singian, G.
Sison, A. G.
Solis, F.
Stafford, H. E.
Start, H. A.
Steinmetz, H. H.
Suanico, M. A.
Takeda, Nobuo
Tirona, J. E.
Tirona, José
Tolentino, M.
Tuason, M.
Tupas, A.
Ubaldo, A. R.
Val, Dario del
Valdez, B.
Varela, José
Vazquez, A. D.
Vazquez, G.
Velarde, H.
Velasquez de Leon, J.
Vera, B.
Victoriano, N.
Villacorta, J. S.
Villalon, A. P.
Villarama, A.
Villegas, A.
Vincent, F. W.
Vitug, W.
Wade, H. W.
Ylanan, C.

# THE MILITARY SURGEON AND THE CIVILIAN PRACTITIONER

By Col. W. B. Banister

*Medical Corps, United States Army*

Mr. President and Gentlemen: When the President of this Society extended an invitation to the military surgeons of the Philippine Department to participate in its proceedings this year I was gratified, as I have long felt that the civilian practitioner and the military surgeon should be brought into closer touch and sympathy, and each acquire a more intimate knowledge of the particular line of development of the other, to our mutual advantage. I know of no better method of establishing a line of contact than the exchange of ideas in a general meeting of the medical profession of these Islands, such as this.

These introductory remarks would lead to the inference that the civilian practitioner and the military surgeon have developed along different lines and, while I admit that their respective development presents many points of contact, I also claim it presents some lines of cleavage as well. The military surgeon has advanced particularly along the line of the etiology of disease with special reference to its bearing on preventive medicine, and the civilian practitioner in the direction of therapeutics, or the curative treatment of disease. This difference has arisen from the character of the responsibilities resting upon each, respectively. The senior surgeon of a military command is held officially responsible for the occurrence of epidemics in armies, and for not stamping out such epidemics when they begin, and at least must show that all the scientific knowledge of his day has been utilized, and if that is not sufficient he is expected to get more scientific knowledge. The principle involved is to get as many bayonets as possible to the battlefield; and, however fine the curative treatment may be, a sick soldier cannot fight, and so becomes a liability rather than an asset. Soldiers are associated together so intimately and in such numbers that armies are peculiarly susceptible to epidemic diseases, and many armies have been defeated by disease rather than by the efforts of their enemies. Brennus undoubtedly would have taken the Capitol at Rome if his army had not been decimated by malarial fever. In the year 208 A. D. the Roman Army in Scotland lost 50,000 out of a total of 80,000 from malarial fever. The expedition in 1740 of English and American Provincial troops against Carthagena failed because of the prevalence of yellow fever in the expeditionary force. Benedict Arnold would undoubtedly have surprised and captured Quebec, Canada, in 1775 but for the occurrence of smallpox in his command during the march through Maine, and thus would have added Canada to the present United States. In 1898, during and after the operations of the Fifth Army Corps against Santiago de Cuba, half of our forces in Cuba were incapacitated for duty by malarial fever.

These are but a few of the many instances that could be quoted to "point a moral or adorn a tale," not to mention the 70,000 cases of typhoid fever in the Prussian Campaign in the Franco-Prussian War of 1870, the 50,000 cases in the English Army in the War in South Africa, and the 20,000 cases that occurred in the United States Army in the Spanish-American War in 1898. It is such experiences as these that have forced the military surgeon to develop along the lines indicated. It may be stated that the diseases that have caused the greatest ravages in modern armies are malarial fever, typhoid fever, yellow fever, and venereal diseases. The plasmodium of malaria was discovered in the red blood corpuscles of malarial patients by Alphonse Laveran, a surgeon in the French Army in Algiers in 1880. Ronald Ross, a surgeon in the English army in India, demonstrated the infection of birds by the bite of the mosquito in 1897–98. The fact that the anopheles mosquito only infected human beings with malaria was demonstrated by Grassi and A. Bignomi in 1899. Charles F. Craig, a military surgeon in the United States Army, demonstrated the possibility of malarial carriers in 1907. Knowing the etiology of malarial fever and its transmission by the anopheles mosquito, the principles involved are simple, namely: keep the men protected from mosquitoes, destroy mosquitoes, and treat carriers so they will cease being carriers and infecting more mosquitoes. From 6,000,000 to 7,000,000 cases of malaria occur annually in the United States. In the military camps only 220 cases were reported among the 4,000,000 men called out.

With regard to typhoid fever, the first work along the present lines among English-speaking people was done by Sir Almworth Wright, a surgeon in the British Army, and in South Africa during the Boer war. The results were, for several reasons, not brilliant. The system worked up for the United States Army by Colonel Russell of our Medical Department has produced brilliant results, and has made typhoid fever almost a negligible item in our morbidity lists. This consists in the injection of 500 million killed bodies of the typhoid bacillus, hypodermically, and of two additional doses, at seven-day intervals, of one billion each. During the World War, in the entire army of the United States in 1917–1918, 1,083 cases of typhoid fever occurred with 158 deaths. If the rate had been the same as for 1898–1899, during the Spanish-American War, when no typhoid prophylaxis was used as at present, the number of cases would have been 291,637 with 30,916 deaths. This method of typhoid prophylaxis could be used by the civilian practitioner to prevent typhoid fever among the civilian population with better prospects of success than in the army, because most cities have sewer systems with water carriage, and many other sanitary advantages. The military surgeon has been using typhoid prophylaxis since 1909 on volunteers, and since 1911 it has been compulsory in the army.

The United States has suffered very severely from yellow fever epidemics, originating principally in Havana, Cuba (and with enormous economic loss), where it has been known to have existed since 1648. Nearly all the epidemics in the southern United States have been traced to Havana. The French were unable to build the Panama Canal because of the ravages of malarial and yellow fever, principally the latter, among the laborers. In 1900, during the American occupation of Cuba, a board of military surgeons of the United States Army, headed by Maj. Walter Reed, demonstrated the method of transmission of yellow fever by the *Stegomyia calopus* mosquito. With this knowledge General Gorgas, a surgeon of the United States Army, attacked the disease in its favorite lair, first in Havana, and eliminated it after it had prevailed there for over 300 years; then with equal success in Panama; and recent reports show that it has been abolished in Guayaquil, Ecuador, its last stronghold, and is now nonexistent on this mundane sphere. The cardinal idea in conquering this disease was to attack it in its lair, and not waste time and money on its outposts.

It was the military surgeons of Japan who first demonstrated that beriberi was a disease due to defects of nutrition. By adding more vitamines to the diet, which consisted principally of fish and rice, it was eliminated from the Japanese Navy. As late as 1883, 23 per cent of the Japanese Navy had beriberi.

During the Russo-Japanese war, 200,000 cases of beriberi occurred in the Japanese Army. Beriberi prevailed extensively among the Philippine Scouts. As late as 1909 nearly 104 per thousand of the Scouts had beriberi. By 1910 the army surgeons on duty with the Philippine Scouts had eliminated beriberi by a change of dietary, in part by the use of undermilled rice.

The incidence of venereal disease in the army has been reduced to one-third of its former prevalence. How? By prophylactic stations ready of access to all soldiers exposed to infection; by lectures to soldiers by medical officers; appeals by posters and by moving-picture shows used as illustrated lectures. We first try to educate the soldier to coöperate with us in preventing venereal disease and, when this fails, by court-martial if he fails to use the prophylactic means provided, and by depriving him of all pay while on sick report from venereal disease. The civilian practitioner may smile and say: "Yes, we know the soldiers have lots, but what has that to do with us?" Well! Statistics of the World War show that 96 per cent of the venereal disease in the army was contracted prior to entry into the military service. If civilian practitioners, as represented by boards of health, etc., would employ methods similar to those of the military surgeons, and we could eliminate that 96 per cent we get from civil life, maybe, I will not say positively, but maybe we could eliminate venereal disease in the army as we did in great part malarial fever, typhoid fever, yellow fever, and beriberi.

Venereal diseases, gentlemen, are a more serious menace to health and happiness among the civilians of present-day civilization than all the other diseases mentioned. Civilian communities have never made any other than desultory and ineffective efforts to rid themselves of venereal infections. The army Medical Department has shown the way. Will the civilian practitioners as a body avail themselves of these proven methods?

The advance of the civilian practitioner in curative medicine is illustrated by the introduction of diphtheria antitoxin, which has saved hundreds of thousands of lives; by Flexner's serum for cerebro-spinal meningitis; by Pasteur's treatment for hydrophobia infection, and so on. While the military surgeon has shown great eagerness to adopt the curative methods introduced by the civilian practitioner, the latter has not shown the same readiness to adopt the preventive methods of the military surgeon, such as typhoid and venereal prophylaxis.

Then came the World War, and the civilian practitioner covered himself with glory through his patriotism in rallying to the flag and his scientific medical knowledge. Prior to April 6, 1917, the regular army had but 447 medical officers, and 1,600 reserve officers who were in civil life. During the war period 35,000 civilian practitioners joined the colors, and about 20,000 served as medical officers of the draft boards in making physical examinations. Over 14,000, the cream of the medical profession in the United States, served in France; and never before in history, with the combination of both the military surgeon and the civilian practitioner, have the soldiers of armies been so well taken care of, both in the prevention of disease and in its cure, and under such unfavorable conditions as prolonged trench warfare. It is true war claimed its millions in dead and disabled, but they were the legitimate losses of war, from shot and shell and gas.

The control of smallpox and typhoid, the two great scourges of armies, was almost absolute. Typhus fever was held in abeyance in armies fighting in Europe by the discovery that the body louse is the transmitter of that disease, and by the extensive system of delousing the armies employed back of the lines; tetanus, by antitetanic serum which was required by orders to be administered to all wounded at the first practicable point, and each wounded man's field card showed where and when it was administered. The infection of wounds by the gas bacillus was prevented to a great extent by the debridement operation, which consisted of laying open the wound freely, and removing all dead or devitalized tissue, including muscle, bone, tendons—in fact, every dead tissue—and removal of all foreign bodies. Unless this was done the dreaded gas infection was very apt to occur. Then there was the Carrell-Dakin treatment of wounds, in which the open wounds were lightly packed with gauze, and kept wet with the Carrell-Dakin solution until the fixed hospital was reached. Then, by frequent cultures made from the discharges from the wound, it was found that, when the organisms had been reduced to a certain number per field of the microscope, the wound could be sutured with confidence that it would then heal by first intention. This treatment saved many lives and prevented much disability. The louse was found to be the cause not only of typhus fever but also of trench fever.

Prior to the war, fifty Red Cross base hospitals were organized in the United States, composed of the élite of the medical profession in the States. These hospitals were the backbone of our hospital system in France, and rendered brilliant service. The medical officers of these hospitals were composed of civilian practitioners with usually a regular army medical officer in command. These and all base hospitals were grouped in what is known as a Hospital Center. A man severely wounded at the front received first aid and antitetanic serum, and was passed back through the regimental aid station, dressing station, and field hospitals to the evacuation hospitals by motor transport. From the evacuation hospitals, which were usually at a rail head, he was taken to a base hospital of a Hospital Center by hospital railroad trains.

One important function of the Medical Department in France was the retention of man power in the theatre of war. Each base hospital had organized a disability board which classified all wounded at that hospital in one of four classes, "A", "B", "C", "D". "A" cases were men who had recovered and were fit for combat duty at the front; "B" cases, not fit for combat duty but rather heavy work in the Service of Supply—that is, in the rear of the battle front; "C" cases were those capable of only light work in the "S. O. S."; and "D" cases were entirely disabled, to be sent back to the homeland.

The Hospital Center was an entirely new idea in our service. It was commanded by a regular medical officer who, aided by a staff, provided the base hospitals in the Center with everything—food, clothes, transportation, medical supplies, laborers, butchers, sanitary squads composed of specially trained enlisted men—which left him to devote all his energies to the care of the sick. Being in command of a Hospital Center I had on my staff an Adjutant, four Quartermasters, an Evacuation Officer to evacuate arriving hospital trains, a R. T. O., a Zone Major, a Provost Marshall, a Medical Supply Officer, a Sanitary Officer, and a chief Laboratory Officer; and attached to Headquarters, an Ambulance Company, a Butcher Company, a Labor Company, and a Sanitary Squad. These hospitals varied from 1,000 to 3,000 beds each. You can understand the necessity of butchers to make an economical cutting of meats in a hospital of 3,000 beds. This Center took care of 9,000 patients at one time, and 23,000 patients passed through the Center from July 2, 1918, to February 1, 1919. A Hospital Center in France was then a big business center to provide the large base hospitals therein with everything they needed.

Since the military surgeon and the civilian practitioner worked together with such brilliant results during the World War, and with ever-increasing mutual esteem and admiration and understanding, would it not be a pity for them to fall apart in time of peace and lose touch, and no longer regard each other as comrades as they learned to do during the World War? It is with the idea of preserving the entente cordiale that I said in the beginning of this lecture that I was gratified when the military surgeons were invited to participate in this meeting of the Philippine Islands Medical Association.

When the civilian practitioner of the Tropics exterminates tropical diseases such as cholera, malarial fever, tropical dysentery, and others, then man can again return unto his birthright. I hold it is a self-evident fact that the Tropics is the natural habitat of man. Before man invented fire and clothes, he could have lived nowhere else but in the Tropics. After these inventions he migrated to other zones, probably driven by tropical diseases which he could not control, to climate conditions where they did not prevail. The military surgeons have shown in Panama and Havana that the Tropics can be made as healthy as any other part of the world. It should be the aspiration of the medical profession of these Islands to make them as healthy as any other country. It is possible, because it has been done in other tropical places, and what man has done, man may do.

# OBSTETRICS AND ITS RELATION TO INFANTILE MORTALITY

By Dr. Fernando Calderon

Puericulture has for its object the study and the practical application of all those measures which tend to protect the life of the product of conception during its first two years of existence; that is, during the most hazardous period in life, because every individual is at this time most exposed to the diseases that man is likely to pass through before he attains his full development.

Some authors distinguish four periods in the evolution or development of the child, and corresponding to these different epochs of life, puericulture is divided into prenatal, intranatal, neonatal, and postnatal. Prenatal puericulture deals with such measures as will safeguard the existence of the embryo from the time it is conceived until it grows into a viable fetus; intranatal puericulture aims to protect the life of the fetus during the brief but hazardous ordeal through which the pregnant woman must pass in order to deliver her child into the world; neonatal puericulture deals with the care of the newly born during the first four weeks of his life; postnatal puericulture aims to give the proper care to the infant from his fifth week of life until he attains his second year of age.

Pregnancy has long been held to be a normal process and, as such, demanded no special care of the mother or of her child. There is nothing that could be farther from the truth. The recent studies of Kellog bear out this statement. Thus, among his 4,996 cases of pregnancy he found the following complications: Albuminuria, 361; high blood pressure, 259; definite symptoms of toxemia, 195; narrow pelves of various grades, 401; cardiac lesions, 111; gonorrhea, 10; chronic nephritis, 5; diabetes, 3; fibroma of lower uterine segment, 30; making a total of 1,524 complicated pregnancies and representing approximately 30 per cent of the cases studied. These figures are significant, and they alone emphasize the necessity of a careful examination of every pregnant woman, to safeguard not only her own life but also that of her child, whose safety is so intimately connected with that of the mother. Briefly summarized, this examination should include the following points:

*a*. Early and complete physical examination of the pregnant woman, especially of the heart, the lungs, the abdomen, and the blood pressure.

*b*. Pelvimetry and cephalometry before the eighth month in primipara in order to ascertain the size of the fetal head and the relative capacity of the birth canal.

*c*. Examination of the urine every four weeks during the first six months of pregnancy, and every two weeks, or oftener if necessary, thereafter.

*d*. Wassermann reaction in suspected cases.

*e*. Examination of the fetal presentation and auscultation of its heart sounds.

*f*. History of previous pregnancies and labors.

From the results of these different examinations one must decide the line of treatment adapted to each particular case, not only to combat whatever complication may endanger the life of the mother, but also to insure the birth of a sound baby.

Although it is not my intention here to present these different complications and their treatment, I might emphazise the fact that a good many abortions and fetal macerations of luetic origin could be averted if adequate treatment were instituted early.

Through intranatal care, which consists essentially of a proper conduct of labor, normal or otherwise, it will be possible to save many lives, for it is a well-known fact that, as macerated fetuses die on account of some disease of the placenta, retroplacental hemorrhages, chronic kidney diseases, syphilis, or other maternal diseases, fresh or nonmacerated fetuses are likewise prone to die on account of some accident of labor, traumatic or otherwise, such as placenta previa, accidental hemorrhages, umbilical prolapse, or unduly prolonged labor. This statement is borne out by the fact that more than half of the fresh fetuses that are delivered stillborn show lesions of cerebral hemorrhage and lacerations of the dura mater from excessive or prolonged pressure, injuries which a competent obstetrician might have easily prevented.

I shall not discuss here the different indications which the obstetrician must meet according to the different complications that may develop in every delivery, but I shall call your attention to the indication of premature delivery or Cesarean section in women with narrow pelves. In these cases the fetuses, left to the unaided forces of nature, are ordinarily delivered dead, when it would have been comparatively easy to save them by means of a premature delivery, or by a timely performance of a Cesarean section, according to the circumstances.

There exists an intimate relationship between prenatal, intranatal, and neonatal puericulture, as is shown by the fact that many fetuses which are sickly and weak at birth bear evidence of having become so while in the maternal cloister, either during pregnancy or during labor. Such happens, for instance, with the congenitally weak, or with those that present symptoms of meningitis secondary to a faulty application of the forceps or as a consequence of injuries sustained by the fetal head in the course of an unduly prolonged labor.

Such is not always the case, however, for a good many times the healthy infant contracts the disease during the first few weeks of his life. Such happens, for instance, in umbilical tetanus, a very serious and fatal infection which develops through the umbilical wound from criminal carelessness or negligence on the part of the attendant. This fatal infection has been completely eliminated in countries where the practice of modern obstetrics has become generalized among the masses; but unfortunately it is still rampant not only in the Philippines as a whole but in its very metropolis, Manila, where according to Professor Albert's investigations it is found that among the 30-day-old babies, 102 out of 110 infections that occurred in the city of Manila in 1913 died from tetanus; 94 out of 100 in 1914; 103 out of 110 in 1915; 96 out of 105 in 1916; 102 out of 108 in 1917.

The same thing is true of the purulent ophthalmia in the newly born, as a consequence of which several children become blind, a complication which is almost always preventable and is likewise attributable to the negligence of the attendant. Unfortunately it has not yet disappeared from the obstetrical annals of this country.

I shall not mention the diseases of the alimentary and respiratory tracts which are so frequent among infants before they reach their thirtieth day. It suffices to say that altogether too many die of such diseases at this age—a vulnerable age—which fact is in itself a strong justification for the spread of puericulture over the entire Philippine Archipelago.

The above remarks are sufficient to show that obstetrics is so intimately associated with prenatal, intranatal, and even neonatal puericulture that, if the obstetrician aims to fulfill the double mission imposed upon him, to save the life of the mother and that of the fetus, he must familiarize himself with the secrets of puericulture in its relation to obstetrics. On the other hand, we must also admit that for the very reason that it is inconceivable to conduct any effective campaign against infant mortality without the help of puericulture, puericulture cannot be effective without the aid of obstetrics. For this reason, if it is desired to carry on a thorough campaign against infant mortality in this country, and at the same time establish puericulture centers, it is necessary to establish also well-organized maternity services which will serve as obstetrical centers, and centers for prenatal, intranatal, and even neonatal puericulture.

Such maternity services could be established in our towns in two different ways: one through visiting nurses and qualified midwives who shall be under a physician's supervision, in order that the patients will be cared for entirely at their homes; the other way would be by establishing hospital maternity departments with their corresponding out-patient service for certain cases. It is evident that the former plan would be cheaper but at the same time less effective and more exposed to failure. Cases of abnormal labor which might be encountered cannot of course be so well attended at the homes of the patients as at the hospital, especially when the conditions surrounding the homes of the patients, for the majority of whom the service is intended, are taken into consideration.

It goes without saying that in default of a hospital maternity service, with its out-patient service, the first plan should be tried, even if, on account of lack of proper personnel who could be trusted with the work, it could not be made at present as extensive as is necessary.

Imbued with these ideas and in my sincere desire to work for the benefit of the people, I took it upon myself to address an official communication to the Honorable the Secretary of the Interior on September 30, 1919, urging that, as a valuable contribution to the solution of the great problem of infant mortality in this country, steps be taken to carry out the provisions of Act 2801 whereby the construction of eight provincial hospitals is authorized, either simultaneously or one at a time, additional hospitals to be constructed and organized as fast as the resources of the Insular Treasury would permit it. These hospitals, which are an every-day need, should be provided with their corresponding maternity services, both hospital and outside. They are to be built of reënforced concrete and first-class timber, and should cost approximately 200,000 pesos each, which would make a total of 1,600,000 pesos for the eight buildings.

It seems just and natural that the provinces that will be directly benefited by the provisions of the above act should contribute their share in the cost of erection and maintenance of these hospitals. They should be expected at least to donate the land on which the hospitals will be erected.

Taking the actual prices as the basis for our estimate, and adopting the Southern Islands Hospital at Cebu with its sixty-five to seventy patients daily as a type, the maintenance of each one of these proposed hospitals will be not less than 80,000 pesos, which would mean a drain of 640,000 pesos a year on the Insular Treasury.

It will not be difficult, however, to find a practical way of reducing each province's share in the cost of maintenance of these hospitals. In the first place, each provincial board could be asked to defray the expenses of conducting the corresponding respective dispensary, for it is evident that the patients the hospital will be called upon to treat will come from every nook and corner of the province. The out-patient maternity department, which at any rate is not expensive, should be paid for by the municipality, in as much as its benefits will be practically monopolized by the expectant mothers of the locality. In order that the hospital may have its own resources, which it will use for defraying part of the expenses of its own maintenance, it will be advisable to fix a reasonable scale of fees, sufficient to cover lodging, board, and ordinary medical assistance, to be paid by patients admitted to the hospital, with the exception of the very poor, to whom no charge whatever should be made.

This proposition is quite equitable, for it suits the local conditions as they obtain in the majority of our provinces where, as is well known, almost everybody owns his small piece of land, and can therefore afford to pay the reasonable hospital fees which will be demanded of him; but the very rich, among whom the service must necessarily be better, should be required to pay higher fees.

All the money derived from these different sources should be deposited in the provincial treasury and, together with whatever might be contributed by the province and the municipality, will doubtless go a long way toward supporting the hospital and obviating the necessity of its depending entirely upon the exhausted resources of the insular treasury. Through such an arrangement the latter will be called upon to cover only whatever deficits may result. A plan similar to the one outlined above is already in operation in the Department of Mindanao and Sulu, and its ten general hospitals hardly cost the Insular Treasury 120,000 pesos a year.

Should this proposition meet with the approval of the authorities and be carried out, it would be advisable to amend Act 2801 in the sense of authorizing the installation of pay sections at the provincial hospitals for the benefit of the well-to-do classes. It would be manifestly unjust to the latter, who are naturally the heaviest taxpayers, to find themselves debarred from the hospital in case of personal sickness or sickness in their own families.

One of the drawbacks to any intensive campaign against infant mortality in this country is the woeful lack of trained personnel that could be trusted with the management of puericulture centers; it might be interesting to know that in the whole Philippines there are altogether not more than 969 practicing physicians, which gives the proportion of 1 physician to every 11,175 inhabitants, as against 1 to every 700 inhabitants in the United States.

This evident shortage of physicians is rendered more acute on account of their irregular distribution, there being in Manila alone not less than 250, while a similar condition prevails to a lesser extent in the smaller cities of Cebu, Iloilo, and Zamboanga, these cities also having a larger share of doctors than the surrounding country. The result of this disproportionate distribution is that, according to figures furnished by the Census Bureau, in many of our towns the number of those that died with any medical assistance at all barely reaches 8.4, and in some it is even as low as 3 per cent.

In order that the population of the Philippines may have a proportional number of physicians there should be a practicing physician for every 3,000 inhabitants, and a sanitary officer for every community of 10,000; in other words, the country is in need of not less than 3,609 clinicians and 1,082 sanitarians, a total of 4,691 instead of the 969 that can be depended on at present. Medicine as a profession is evidently not very attractive to our young men.

The disproportion is even more striking in the case of nurses, the records of the Board of Examiners for Nurses giving only 672 registered nurses, which would allow a nurse to every 16,114 inhabitants. It must be remembered, however, that nursing is a comparatively new calling in this country, the first graduate nurses having received their diplomas only nine years ago, while medicine is one of the oldest learned professions in the country.

From the foregoing facts the following propositions are submitted:

1. An amendment to Act 2801, in the sense of authorizing the installation of pay sections at the provincial hospitals for the benefit of the well-to-do classes.
2. The enactment of a law authorizing the appropriation of 1,600,000 pesos for carrying out the plans for building eight provincial hospitals with their corresponding maternity services.
3. The immediate organization of maternity service to patients at their homes in such towns as may have a sufficient number of physicians and nurses to carry on the work.
4. The appointment of a committee to study and propose such measures as will make the medical profession more attractive to our young men.

# CLINICAL ANALYSIS OF ONE HUNDRED CASES OF ENTEROCOLITIS WITH ESPECIAL REFERENCE TO EDEMA, DEHYDRATION, AND PUTRID ODOR OF STOOLS

By DRS. JOSÉ ALBERT and FÉ HORILLENO

These one hundred cases were observed from May 1 to November 11, 1919, during which time the yearly outbreak of bacillary dysentery usually takes place in this city, especially during the months of June and July.

All these cases were examined by Professor Haughwout, and no single case was found positive for entamœba histolytica, thus confirming previous experience as to the rarity of this kind of dysentery in children. The object of this paper is to present certain clinical features of acute enterocolitis as observed in the children's ward. Rather than express an opinion on the many conclusions arrived at with reference to this important infection, we will present some facts and figures; and before taking up the discussion of the edema, dehydration, and putrid stools we will present some tables which we think will be of value for the better interpretation of this dreadful disease.

The following tables are self-explanatory and require but few comments.

The first table gives the morbidity of the six commonest and most important diseases in children; the second represents the mortality of the epidemic of enterocolitis during this year; the third, the distribution of the cases according to different ages; the fourth, the final cause of death; the fifth, the day of death; the sixth, the number of stools in twenty-four hours on admission of those who died (this gives the relation between the number of stools and the fatality); and the seventh, the average duration of the disease in those who recovered.

TABLE 1.—*Most important diseases admitted from May 1 to November 11, 1919.*

| | |
|---|---|
| Total admissions | 397 |
| Pneumonias, lobar and lobular | [a] 121 |
| Typhoid | [b] 21 |
| Nephritis | 13 |
| Beriberi | 11 |
| Meningitis | 6 |
| Ileocolitis or dysentery | 100 |

[a] Ten, or 8 per cent, died. [b] Three, or 13 per cent, died.

TABLE 2.—*Cases that recovered or improved, and cases that died.*

| | |
|---|---|
| Recovered or improved | 59 |
| Died | 38 |
| Discharged against advice, in serious condition | 3 |

TABLE 3.—*Distribution of cases according to age.*

| Age. | Cases. | Died. | |
|---|---|---|---|
| | | Number. | Per cent. |
| Under 1 year: | | | |
| Breast-fed | 5 | 1 | 20 |
| Artificially fed | 11 | 9 | 81 |
| | 16 | 10 | 60 |
| From 1 to 2 years | 30 | 14 | 46 |
| Over 2 years | 54 | 14 | 25.9 |

TABLE 4.—*Cause of death.*

| | Cases. |
|---|---|
| Toxemia | 16 |
| Bronchopneumonia | 14 |
| Gingivitis, gangrenous | 5 |
| Furunculosis | 1 |
| Pyelocystitis | 1 |
| Progressive cachexia | 1 |

TABLE 5.—*Day of death.*

| | Cases. |
|---|---|
| Before the 7th day | 7 |
| On the 8th to the 15th day | 8 |
| On the 16th to the 23d day | 7 |
| On the 24th to the 30th day | 9 |
| After the 30th day | 7 |

TABLE 6.—*Number of stools in twenty-four hours on admission of those who died.*

| | Cases. |
|---|---|
| Less than 10 stools | 20 |
| 11 to 21 stools | 16 |
| 22 to 32 stools | 1 |
| More than 32 stools | 1 |

TABLE 7.—*Total duration of disease in those improved or recovered.*

| Cases. | Days. |
|---|---|
| 19 | 16 to 23 |
| 12 | 24 to 31 |
| 9 | 8 to 15 |
| 7 | 32 to 39 |
| 4 | 40 to 47 |
| 8 | 47 + |

3 discharged against advice, in serious condition.

It will be seen that the average duration in over 50 per cent of those with favorable course is from three to four weeks; complete recovery is seldom reached before two weeks.

### EDEMA

The survey of these one hundred cases showed that thirty-seven presented edema, twelve of which died. Edema may be considered therefore as a not infrequent symptom of enterocolitis in children.

It appears ordinarily after the first week of the onset of the disease, more commonly in the face; and, contrary to the opinions of others, our experience has shown that when it appears at the end of the first week it usually means a favorable outcome; that is, that we may look upon it as the forerunner of convalescence. In such cases the edema lasts only a few days and the retention of fluids by the tissues seems to favor disintoxication by diluting toxins.

However, when it appears very late in enterocolitis with protracted course and frequent relapses, this symptom must be considered an unfavorable sign of prognosis, indicating chronic advanced toxemia or cachexia, or a complication of the kidney.

### DEHYDRATION

Dehydration, desiccation, exsiccation, or anhydremia as it has lately been called by Marriott, of St. Louis, is another symptom to be taken into consideration in acute enterocolitis. Thirty-nine of the one hundred cases presented this symptom, of which twenty-two died. It is therefore a sign of unfavorable prognosis.

One distinguished English authority said, in connection with the great importance of this symptom in the treatment of this disease: "while the bacteriologists are discussing the types of bacilli, the patient died on account of the dehydration which increases the absortion of the toxins."

This symptom when very marked appears in infants as the clinical picture called "Habitus Toxicus;" namely, eyes sunken, features sharpened, angles of the mouth drawn down, peculiar pallor, fontanelles depressed, overlapping of the cranial bones, reduced turgor of the skin, and an expression of anxiety overspreading the whole countenance.

It augurs a very unfortunate outcome and demands an immediate supply of fluid by hypodermoclysis or phleboclysis in order to check the severe toxemia.

PUTRID ODOR OF STOOLS

We recorded eleven cases of this kind of stools, considered by French authors as a sign of gangrenous enterocolitis, and we have been impressed with its bad significance in regard to the prognosis. Eight cases with this sign died among the eleven, giving a mortality of 72 per cent.

# THE COMPLEMENT FIXATION TEST FOR SYPHILIS: INCUBATION FOR FIXATION AT ICE-BOX TEMPERATURES

By First Lieut. JOSEPH W. SMITH, Jr.
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To designate the Wassermann reaction as a complement-fixation phenomenon is not strictly in accord with our knowledge of the test. The reaction was at first regarded as an immunity test depending upon a reaction between antibodies specific for *Spirochæta pallida* on the one hand, and the specific protein constituents of this pathogenic organism on the other. Looked at in this way, a positive test would indicate the existence of specific syphilis antibodies in the serum of a patient. This conception was perforce abandoned several years ago. It has been amply demonstrated that extracts of cultures of *Spirochaæta pallida* as well as extractions from the testes of syphilitic rabbits do not furnish an antigen suitable for the Wassermann reaction. At present it is quite generally believed that the test is not a specific complement-fixation in the sense of Bordet and Gengou, but that it is a somewhat analogous reaction, dependent upon the presence, in the serum of syphilitic patients, of substances produced indirectly because of the presence of syphilitic infection. It may be a relative increase of globulins, or a change in the physical state of the globulins or of other substances present in the serum.

None of the theories of the Wassermann reaction has been definitely proven; all are still only theories, or probably really no more than hypotheses. However, despite the lack of logical, theoretical considerations in relation to the test, and although much that has been said and written and done regarding it has been erroneous, the Wassermann reaction has a soul of truth and has persistently survived all manner of abuse and mutilation. It finds its justification in its practical value, attested by experience. As a necessary corollary it results that a proposed antigen or a proposed technic finds favor not according to its theoretical specificity but only through extensive and satisfactory use upon a large series of patients. Although clinical satisfaction cannot be accepted without reserve as final proof of scientific accuracy, in the long run it is a very safe criterion. In the case of the Wassermann reaction, clinical satisfaction is our only criterion. This may be rather distasteful to some of us who have been prone to decry empiricism. The Wassermann reaction is purely empirical in the sense that it is experimental rather than scientific. The failure to appreciate this fact has led many physicians astray. It has led to errors both in the laboratory and at the bedside. The laboratory worker should not fail to check his results, whenever practicable, with the clinical aspects of the cases. The clinician should never regard the Wassermann reaction as an infallible means to the easy diagnosis of syphilis. He is perfectly correct in looking upon a positive Wassermann reaction as the most constant single symptom of lues. But before a clinician accepts a report as positive he should have done one of two things: either he should have supplied the laboratory man with all available clinical data, or he should have familiarized himself with the particular test which is done in the laboratory to which he sends his sera so that he is himself in a position to interpret the test. Until such time as the test shall have been standardized and made "fool proof," certainly one or the other of these alternatives should be adopted.

It is well recognized that widely different results may be obtained in Wassermann reactions by the use of different antigens, and by the employment of different incubation conditions even with the same antigen. In a communication published [1] in collaboration with Dr. Ward J. MacNeal, I reported upon Wassermann tests done by me in the laboratories of the New York Post-Graduate Medical School and Hospital by three methods, on 496 identical specimens of sera and spinal fluids from 477 patients. In the first method a cholesterin-reënforced antigen was employed, and the first incubation was carried out at 37° C. In the second method a simple alcoholic extract was used as antigen, with incubation also at 37° C. In the third method the latter antigen was again employed, but the first incubation was carried out in the refrigerator for from four to twenty-four hours. The last method proved more sensitive in the group of known syphilitics than the other procedures tested. Furthermore, a positive result thus obtained proved to be more trustworthy evidence of syphilis than did positive results obtained with the cholesterin-reënforced antigen and first incubation at 37° C.

[1] Journ. Immun. 2 [1] (1916).

In a second paper [2] Doctor MacNeal and I presented the results of Wassermann tests performed in the laboratories of the New York Post-Graduate Medical School and Hospital by six methods, on 501 identical specimens from 457 patients. In the first of these six methods a cholesterin-reënforced antigen was employed, and the first incubation was carried out at 37° C. In the second method a simple alcoholic extract was used as antigen, with incubation also at 37° C. In the third method an antigen prepared from the acetone-insoluble fraction of beef heart after the method of Noguchi was used, with incubation also at 37° C. Exact duplicates of these tests were prepared and incubated at 8° C. for four hours. Tests 4, 5, and 6 differed from tests 1, 2, and 3, respectively, only in the temperature and the length of time for the first incubation.

Each antigen was titrated for hemolytic effect, for anticomplementary action, and for specific antigenic property. The titrations were made for each set of incubation conditions, that is 37° C. for one hour and 8° C. for four hours.

The hemolytic system used was the sheep-rabbit system. Two units each of ambo and complement were used in the tests. This system is quite sufficiently loose to obviate very largely the danger of nonspecific fixation. And yet, as will subsequently appear, we found reactions in 16 of the 501 tests (3 per cent), which we feel inclined to regard as false positive reactions.

The sera and spinal fluids were always heated at 56° C. for thirty minutes just prior to being tested.

The cases presented were divided into two classes, on the basis of history. The known syphilitics made up the first class. In this group were recorded 92 reactions in 80 cases. At 37° C. antigens B.H.C. (cholesterinized extract of beef heart), B.H.P. (simple alcoholic extract of beef heart), and B.H.A. (acetone-insoluble extract of beef heart) yielded, respectively, 52, 26, and 31 per cent of positive reactions, while by the ice-box method, on the other hand, they gave in the same order 76, 64, and 48 per cent of positive tests.

The second class of cases was composed of those in which there were no histories of syphilis. On the basis of the physical findings it was possible to form several subdivisions of this group, the first of which consisted of those cases which presented lesions typically luetic. In 27 reactions in 24 patients in this group the results were as follows: At 37° C., cholesterinized extract of beef heart, simple alcoholic extract of beef heart, and

[2] Journ. Inf. Dis. 21 [3] (1917).

acetone-insoluble extract of beef heart, 92, 66, and 77 per cent, respectively; at 8° C., 100, 92, and 88 per cent, respectively. The second subdivision, those probably syphilitic although not evidently so, consisted of 20 patients upon whom 25 tests were done with the following results: At 37° C., cholesterinized extract of beef heart, simple alcoholic extract of beef heart, and acetone-insoluble extract of beef heart, 84, 48, and 68 per cent, respectively; at 8° C., 92, 88, and 80 per cent, respectively.

We came then to another group of cases in which again there were no histories of syphilis nor of antisyphilitic treatment. In some of them the physical findings were rather vague and the clinical diagnoses not stated with any degree of assurance, but in others the findings were quite definitely not those of syphilis and the diagnoses were of conditions not syphilitic; such, for example, as acute articular rheumatism and typhus fever. In this group we had 16 patients with 16 tests. In all of these there was complete or partial fixation of complement with antigen cholesterinized extract of beef heart, either at 37° C. or at 8° C., or both, associated with absence of fixation with either of the other antigens. We feel rather confident that the cases in this last group were not syphilitic and that the complement fixation obtained in them was nonspecific. The cholesterin-reënforced antigen was the only one to give positive results in this group and it appeared to be more unreliable at the higher temperature than at the lower.

There were 341 tests on 317 nonsyphilitics, in none of which was any degree of fixation obtained with any of the antigens under either condition of incubation. Thus, in 357 tests on 333 nonsyphilitic patients the cholesterin-reënforced antigen gave positive results in 2.2 per cent at 37° C. and in 1.4 per cent at 8° C.

As a result of these studies Doctor MacNeal and I were convinced, first, that the use of the cholesterinized antigen with first incubation at 8° C. for four hours constitutes a more sensitive test for syphilis than does any of the other methods examined; secondly, that the cholesterinized antigen, both at 37° C. and at 8° C., is apt to yield nonspecific fixation. Therefore, in a diagnostic reaction, fixation with the cholesterinized antigen alone is at best of only doubtful significance. We were further convinced that the simple extract antigen, with the first incubation at 8° C., is more sensitive than the cholesterinized antigen at 37° C., and in this series it gave no false positive reactions, according to the available evidence.

On the strength of these results we adopted the ice-box Wassermann, using the simple alcoholic extract of beef heart antigen as our routine test at the New York Post-Graduate Medical School and Hospital. When I visited there in August of last year it was still giving excellent satisfaction.

The routine Wassermann reaction done in the laboratories of the New York City Department of Health is the ice-box test, using the simple alcoholic extract antigen. The value of fixation at ice-box temperature was pointed out in New York City as early as 1912, by Dr. Archibald McNeil, then of the Department of Health. O. Berghausen[3] has recently commented on the superiority of ice-box fixation. He has adopted it as routine in his laboratory. E. H. Ruediger[4] has lately made rather extensive studies of the relation of temperature to complement-fixation. He endorses ice-box fixation.

It is my belief that incubation at 8° C., or thereabouts, for from four to twenty-four hours, and the use of two antigens, one a simple alcoholic extract and the other a cholesterinized extract, makes a very much more sensitive test and also a far more reliable test than that which is ordinarily done. In known syphilitics the reaction with the cholesterinized antigen may be used as a guide to treatment. In a diagnostic test the reaction with the simple alcoholic extract antigen may be relied upon.

In closing, let me add that, no matter how delicate the reaction nor how reliable or specific it may be reputed to be, one should never diagnose syphilis on a single positive Wassermann reaction alone. Keep the patient under observation and under suspicion. Go over him again and again. Look especially to his aortic arch. Have the test repeated. Have it done, if possible, by the ice-box method with a simple alcoholic extract antigen. If it is then positive you may feel justified in putting your patient upon antiluetic treatment.

[3] Journ. Am. Med. Assoc. (1919).

[4] Journ. Inf. Dis., two recent contributions.

# DIPHTHERIA IN THE PHILIPPINE ISLANDS

By Drs. LIBORIO GOMEZ, AMANDO M. KAPAUAN, and CATALINO GAVINO

Diphtheria is not a frequent disease in the Philippine Islands, but it has been apparently on the increase in the last few years or else it is beginning to be more widely recognized. It was thought advisable, therefore, to give a brief description of the disease as it occurs in the Islands, based on data obtained from the records of the Philippine Health Service, the San Lazaro Hospital, the department of pathology of the University of the Philippines, the Bureau of Science, and from personal observations.

## INCIDENCE

Practically all the data regarding the incidence of the disease are drawn from the Health Service statistics for the city of Manila, as the reports from the provinces are rather incomplete and unreliable. The following figures (Table 1), taken from the annual reports of the Director of the Philippine Health Service, cover the period from 1900 to 1918 and indicate cases and deaths that are either positive clinically only or positive clinically and bacteriologically.

TABLE 1.—*Diphtheria in Manila.*

[From reports of the Bureau of Health.]

| Fiscal year. | Cases. | Deaths. | Fiscal year. | Cases. | Deaths. |
|---|---|---|---|---|---|
| 1900 | 1 | 1 | 1910 | 28 | 10 |
| 1901 | 0 | 0 | 1911 | 25 | 16 |
| 1902 | 4 | 4 | 1912 | 49 | 17 |
| 1903 | 2 | 2 | 1913 [a] | 1 | (?) |
| 1904 | 4 | 4 | 1914 | 38 | 13 |
| 1905 | 7 | 7 | 1915 | 59 | 23 |
| 1906 | 8 | 8 | 1916 | 114 | 30 |
| 1907 | 15 | 13 | 1917 | 79 | 27 |
| 1908 | 18 | 9 | 1918 | 45 | 15 |
| 1909 | 7 | 0 | Total | 504 | 199 |

[a] Last six months of the year.

The disease occurs sporadically, not any one district of Manila being particularly affected. It does not seem to be very contagious, and usually no definite outbreak of the disease in the immediate neighborhood of the affected cases could be traced. There was only one instance in 1918 and one in 1919 of cases occurring in the same household, the persons affected being brothers and sisters.

There is an impression among practicing physicians that diphtheria is liable to occur oftener in damp, cold weather when other catarrhal affections of the respiratory tract are more frequent; but the statistics of the Health Service for four years from 1915 to 1918 and the records of cases treated in San Lazaro Hospital in 1919, presented in Table 2, do not show any particular seasonal incidence.

TABLE 2.—*Monthly incidence of diphtheria.*

| Month. | Diphtheria in Manila (Bureau of Health). | | | | San Lazaro Hospital. |
|---|---|---|---|---|---|
| | 1915 | 1916 | 1917 | 1918 | 1919 |
| January | 4 | 13 | 16 | 15 | 2 |
| February | 2 | 4 | 7 | 5 | 3 |
| March | 4 | 5 | 13 | 5 | 4 |
| April | 4 | 17 | 1 | 9 | 7 |
| May | 6 | 5 | 1 | 2 | 4 |
| June | 3 | 11 | 6 | 3 | 8 |
| July | 6 | 7 | 4 | 2 | 6 |
| August | 3 | 16 | 9 | 0 | 3 |
| September | 4 | 13 | 8 | 1 | 7 |
| October | 7 | 7 | 6 | 1 | 2 |
| November | 8 | 9 | 5 | 0 | 2 |
| December | 8 | 7 | 3 | 2 | 5 |

No race is exempt. Among sixty-two cases of diphtheria treated in San Lazaro Hospital during the entire year 1919 and the months of January and February of 1920, there were fifty-six Filipinos, three Chinese, two Spaniards, and one American mestiza. Among the twenty-seven cases autopsied at the College of Medicine and Surgery, University of the Philippines from 1908 to 1920, there were twenty-four Filipinos, one Russian, one American, and one American mestiza.

Diphtheria occurs most frequently in children during the first five years of life. Among the sixty-two cases admitted to San Lazaro Hospital as noted before thirty-four, or 54.8 per cent, were children from 2 to 5 years of age; nineteen, or 30.6 per cent, under 2 years of age; six, or 9.6 per cent, from 6 to

10 years of age; three, or 4.8 per cent, were more than 15 years of age, one being an adult 35 years old.

There seems to be a greater prevalence in males than in females. There were thirty-six males and twenty-six females in the San Lazaro cases, nineteen males and eight females in the autopsy cases.

## CLINICAL RÉSUMÉ

This is based on the clinical records of cases diagnosed clinically as diphtheria in San Lazaro Hospital during 1919 and January and February of 1920. Altogether sixty-two cases have been studied, in thirty-one of which the diagnosis was confirmed bacteriologically.

The patients are usually admitted to the hospital with the following symptoms noted by the relatives: Slight fever, cough, sore throat, difficulty in swallowing, stertorous and difficult breathing, and more or less cyanosis.

The local findings are similar to those in other countries; there is a hyperemia of the pharynx extending beyond the pillars of the fauces and a characteristic grayish white pseudomembrane which leaves a bleeding surface when detached. The pseudomembrane most often involves both tonsils, frequently extending to the uvula and to a slight extent to the pharynx, soft palate, and larynx. Three cases were diagnosed as diphtheria but showed no typical membrane, one case showing only some white mucus patches on the tonsils; on bacteriological examination, however, this case was found positive for the Klebs-Loeffler bacillus.

The fever is rather low in the majority of cases, as shown by the following data taken on admission from sixty-one patients. In one case the temperature was not taken as the patient was practically in a dying condition when admitted.

TABLE 3.—*Temperature on admission.*

| Temperature. | Patients. | Per cent. |
|---|---|---|
| 37° C or below | 9 | 14.7 |
| 37° but less than 38° C | 15 | 24.2 |
| 38° but less than 39° C | 30 | 49.1 |
| 39° but less than 40° C | 6 | 9.8 |
| 40° or above | 1 | 1.6 |

The pulse rate is accelerated, ranging as a rule from 100 to 120 per minute, depending on the age of the patient, the temperature, toxic symptoms, and heart complications. There was no study on abnormal characters of the pulse. Of the sixty-two cases studied there were seventeen whose pulse rate averaged 130 per minute or higher. This tachycardia seems to bear relation to the prognosis; among the seventeen cases of rapid pulse rate there were eleven with 130 per minute, four, or 36.3 per cent, of whom died; five cases with 140, three, or 60 per cent, of whom died; and one case with 150, that proved fatal. The above concurs with the studies of Hibbard and Burrows(3) as to the importance of the pulse rate in regard to the prognosis.

The respiration ranges between 22 and 28 per minute, a rate of 30 or above usually indicating danger.

The disease lasts on an average from five to nine days, depending to some extent on the promptness of the administration of antitoxin and the presence of complications. In our study there were twelve cases in which the disease lasted from ten to twenty days and one case that lasted fifty-two days.

The disease was frequently complicated with bronchopneumonia and albuminuria. Our data regarding post-diphtheritic paralysis are rather meager. Dr. Victor Sevilla, a throat and nose specialist, told us in a personal conversation of two cases that had come under his observation in which paralysis of the soft palate had occurred as a sequel to diphtheria. In the Philippine General Hospital there is a record of one case, in the service of Dr. José Albert, some of the symptoms of which might have been brought about by a previous attack of diphtheria. The patient was a Filipino child, female, 3 years old, admitted to the hospital on April 9, 1919. A diagnosis of diphtheria was made and the child was transferred immediately to San Lazaro Hospital where the diagnosis was confirmed. The patient was discharged as cured on April 16, 1919. On May 27, 1919, she was again admitted to the Philippine General Hospital suffering from aphonia, strabismus, paralysis of the muscles of the neck, paresis of the lower extremities, bronchopneumonia, and acute dilatation of the heart. She died the next day, May 28; no autopsy was made.

Among the sixty-two cases here studied, there was one case of nasal diphtheria; the patient was a Filipino male child, 2 years old, and was sent to the hospital by Doctor Sevilla. This case showed the following interesting points: The child was sick forty-four days previous to admission and eight days in the hospital; there was beginning paralysis of the soft palate; the temperature, at least while the child was in the hospital, was practically normal, except one day when it rose to 37.4° C.

as a result of injection of diphtheria antitoxin; there was no throat involvement.

A practically pure culture of *Bacillus diphtheriæ,* of the short variety, type E of Wesbrook, was isolated from the nose but not from the throat. This strain was of rather low virulence (see No. 16, Table 4). The patient recovered completely after having been treated with 8,000 units of diphtheria antitoxin, and washings of the nose and throat with alkaline antiseptic solutions.

## BACTERIOLOGY

In only thirty-one of the sixty-two cases studied in San Lazaro Hospital was the diagnosis confirmed bacteriologically. This is probably due to faulty technic with the early cases of the series, for when more attention was paid to the bacteriological work a greater number of positive results was obtained. Twenty-one, or 87 per cent, of twenty-four cases admitted to San Lazaro Hospital from September 26, 1919, to February 23, 1920, were positive. In twenty of these the bacillus was isolated in pure culture and the characteristics of the different strains studied, as shown in Table 4.

The cultures were made in Loeffler's blood serum, and all showed Gram positive bacilli with more or less V-shaped arrangement, characteristic polar bodies specially demonstrable by the Neisser Gin stain, producing acid reactions in Hiss' serum water carbohydrate media as follows; strong in the glucose, weak in the dextrin, and none at all in the saccharose. In practically all cultures the various types of Wesbrook, Wilson, and McDaniel could be identified, but we present in Table 4 only the most predominant one as seen in smears of from eighteen to twenty-four hours old Loeffler's blood serum culture.

The virulence test was performed according to the method recommended by Kolmer and Moshage; (4) that is, subcutaneous injection into a 250- to 300-gram guinea pig of 4 cubic centimeters of a 10 cubic centimeter salt solution emulsion of a twenty-four hours old Loeffler blood serum culture. With eighteen of the cultures the guinea pig died within two days after inoculation showing, on autopsy, characteristic subcutaneous gelatinous œdema, which was sometimes hæmorrhagic, and intense congestion of the suprarenal glands. In one culture (No. 17) the guinea pig died after five days with congested adrenals, hæmorrhage, and necrosis, but no characteristic subcutaneous œdema. In another (No. 2) the guinea pig was alive twelve days after inoculation, showing no characteristic

TABLE 4.—*Bacteriology of clinical cases.*

| No. | Name. | Age. | | Sex. | Disposition. | Date of obtaining the culture. | Morphology type. | Acid reaction. | | | Virulence. | | Days alive after injection. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Glucose | Saccharose. | Dextrin | Œdema. | Adrenals. | |
| | | *Yrs.* | *mo.* | | | | | | | | | | |
| 1 | R. B. | 3 | | F | Cured | Sept. 27, 1919 | B | + | – | + | + | + | 2 |
| 2 | A. R. | 10 | | F | Died | Oct. 19, 1919 | E | + | – | + | – | – | [a] 12 |
| 3 | M. M. | 9 | | F | Cured | Nov. 12, 1919 | C | + | – | + | + | + | 2 |
| 4 | E. S. | 1 | 8 | M | Died | Nov. 24, 1919 | C | + | – | + | + | + | 2 |
| 5 | N. R. | 2 | 8 | F | do | Dec. 13, 1919 | B | + | – | + | + | + | 1 |
| 6 | S. R. | 5 | | F | Cured | Dec. 13, 1919 | B | + | – | + | + | + | 1 |
| 7 | A. B. | 1 | 4 | M | do | Dec. 16, 1919 | B | + | – | + | + | + | 2 |
| 8 | F. A. | 2 | | M | Died | Dec. 21, 1919 | B | + | – | + | + | + | 1 |
| 9 | J. T. | 2 | | M | do | Jan. 22, 1920 | C | + | – | + | + | + | 2 |
| 10 | C. S. | 5 | | F | Cured | Jan. 26, 1920 | A | + | – | + | + | + | 2 |
| 11 | C. V. | 3 | | M | Died | Jan. 30, 1920 | B | + | – | + | + | + | 2 |
| 12 | J. V. | 3 | | F | do | Feb. 4, 1920 | C | + | – | + | + | + | 2 |
| 13 | A. J. | 2 | | M | Cured | Feb. 6, 1920 | A | + | – | + | + | + | 2 |
| 14 | G. V. | 35 | | F | do | Feb. 14, 1920 | B | + | – | + | + | + | 2 |
| 15 | C. T. | 2 | | M | Died | Feb. 11, 1920 | C | + | – | + | + | + | 2 |
| 16 | P. F. | 2 | | M | Cured | Feb. 13, 1920 | E | + | (b) | + | (c) | + | 5 |
| 17 | E. B. | 5 | 6 | M | do | Feb. 13, 1920 | B | + | – | + | + | + | 1 |
| 18 | N. E. | 2 | 4 | M | Died | Feb. 18, 1920 | D | + | – | + | + | ± | 1 |
| 19 | M. T. | 1 | 6 | F | do | Feb. 20, 1920 | C | + | – | + | + | + | 2 |
| 20 | L. S. | 8 | | F | Cured | Feb. 23, 1920 | C′ | + | – | + | + | + | 1 |

[a] The virulence test was done three times. One guinea pig died five days after inoculation; another died after nineteen days, showing in no case characteristic changes.

[b] There was apparently some decoloration and coagulation.

[c] The guinea pig on autopsy showed hæmorrhagic and necrotic area around the site of inoculation but no characteristic œdema.

symptoms. In view of these findings we consider eighteen of the cultures virulent, one weakly virulent, and one avirulent.

## PATHOLOGY

There were, altogether, twenty-seven autopsies made at the College of Medicine and Surgery, University of the Philippines, since 1908 up to the time of the writing of this paper. In eighteen of these positive bacteriological diagnoses were made.

The cases autopsied were usually fairly well-nourished children, in which, on opening the throat organs, a definite dirty white-gray pseudomembrane was shown which left an abraded mucosa when torn off. This membrane was firmly adherent at times, and easily detached or practically loose at others, causing a more or less mechanical stenosis of the respiratory passages. There was also found congestion of the lungs, or definite bronchopneumonia, which was at times hæmorrhagic. The kidney and liver exhibited more or less parenchymatous degeneration, and the spleen, lymphoid hyperplasia. The heart also showed parenchymatous degeneration and more or less dilatation of the right side. There was only one autopsy in which there was a distinct record of a fatty heart on gross examination. There were thirteen cases, or 48 per cent, which showed bronchopneumonia. There is no record of histological examinations in any of these autopsies.

The location of the membrane is interesting because of its striking frequency in the larynx as compared with figures from other countries, such as those given by Osler(5) in Table 5, where percentages are given in relation to the total number of cases showing membrane, which gives a lower relative percentage for the Philippine autopsies than would be the case were the figures compiled from the total number of cases.

TABLE 5.—*Location of diphtheritic membrane.*

| Location. | Osler's cases.[a] | | Philippine cases. | |
|---|---|---|---|---|
| | | *Per cent.* | | *Per cent.* |
| Tonsils | 65 | 51.1 | 15 | 57.6 |
| Pharynx | 51 | 40.1 | 12 | 46.1 |
| Larynx | 75 | 58.8 | 24 | 92.3 |
| Epiglottis | 60 | 47.2 | 6 | 23.0 |
| Trachea | 66 | 51.9 | 9 | 34.6 |
| Bronchi | 42 | 33.0 | 3 | 11.5 |
| Stomach | 5 | 3.9 | 1 | 3.7 |
| Duodenum | 1 | 0.7 | 1 | 3.7 |

[a] Osler's figures are compiled from 220 autopsies showing membrane present in 127, or 55.4 per cent; whereas the figures for the Philippines are taken from 27 autopsies showing membrane present in 26, or 96.3 per cent.

MORTALITY

Looking over the summary of yearly reports of the Philippine Health Service regarding incidence of the disease in Manila (Table 1) from 1900 to 1918, we find five hundred four cases of which there were one hundred ninety-nine deaths, or 39.4 per cent. From the sixty-two cases admitted to San Lazaro Hospital during 1919 and first two months of 1920 there were twenty-three deaths, or 37 per cent. Confining ourselves to those cases which were bacteriologically confirmed in this last series we find that out of thirty-one cases bacteriologically positive, there were twelve deaths, or 38.7 per cent.

The mortality is greatest during the first five years of life. In the San Lazaro Hospital cases there were seven deaths, or 36.8 per cent, in nineteen children under 2 years of age; fourteen deaths, or 41.1 per cent, in thirty-four children from 2 to 5 years old; two deaths, or 33 per cent, in six children 6 to 10 years old; and no death in the three cases more than 15 years of age. Among the twenty-seven autopsy cases there were thirteen children, or 48.1 per cent, under 2 years of age; ten, or 37 per cent, from 2 to 5 years of age; two, or 7.4 per cent, from 6 to 10 years; and two, or 7.4 per cent, adults.

The percentage of mortality is rather high, especially if we take into consideration the fact that the cases admitted to San Lazaro Hospital were injected at once with antitoxin without awaiting the results of bacteriological examination. It corresponds to the mortality in cold countries in the pre-antitoxin era but is much higher than that shown by statistics subsequent to the introduction of antitoxin, which is only about 14.6 as against 9.8 per cent (Osler).

This high mortality was already remarked upon by Dr. Salvador V. del Rosario,(2) chief of Manila Sanitation. He suggests that it might be due to atypical mixed infections or to the tardy administration of antitoxin following delayed diagnosis. The last supposition is contradicted by the meager information regarding the prevalence in Manila or in the Philippine Islands of post-diphtheritic paralysis which is so commonly observed in recovered cases of genuine diphtheria to follow upon the belated administration of the antitoxin.

In isolating *Bacillus diphtheriæ* we have paid no attention to other concomitant bacteria; but we have observed streptococci in abundance in at least two cases, one of which recovered promptly, and the other proved fatal. If we examine the number of days the patients were sick before reporting to

San Lazaro Hospital, which is practically the period that elapsed before the administration of the antitoxin, we find that there is no marked difference between the cases that recovered and those that proved fatal, as shown in Table 6.

TABLE 6.—*Number of days sick previous to admission to San Lazaro Hospital or antitoxin treatment.*

| Days. | Cases. | | | |
|---|---|---|---|---|
| | Recovered. | | Fatal. | |
| | | *Per cent.* | | *Per cent.* |
| 1 | 3 | 7.6 | 2 | 8.6 |
| 2 | 4 | 10.2 | 1 | 4.3 |
| 3 | 5 | 12.8 | 1 | 4.3 |
| 4 | 8 | 20.5 | 10 | 43.4 |
| 5 | 5 | 12.8 | 3 | 13.0 |
| 6 | 4 | 10.2 | | |
| 7 | 3 | 7.6 | 3 | 13.0 |
| 8 | 3 | 7.6 | 1 | 4.3 |
| 9 | | | 1 | 4.3 |
| Undetermined | 4 | 10.2 | 1 | 4.3 |
| Total | 39 | | 23 | |

Brownlee(1) states that in England the disease is, as a rule, most fatal in towns where it is least prevalent, and Park and Bolduan(6) think that in some instances this is due to the fact that in years when the disease is not epidemic the proportion of laryngeal cases is greater than usual. This seems to tally with the experience in the Philippines where, as shown by the autopsy records, distinct diphtheritic laryngeal lesions were found in twenty-four out of twenty-seven cases of diphtheria autopsied by the pathologists of the University of the Philippines. Such lesions would naturally aggravate the disease by mechanical obstruction, increased toxemia due to the greater extent of the membrane, and greater liability to bronchopneumonia that may be brought about by aspiration.

## SUMMARY

1. Diphtheria occurs in the Philippine Islands and shows practically the same clinical manifestations and bacteriological and pathological findings as in other countries.

2. It is rather infrequent and does not seem to be so contagious; nor does it develop in epidemic form.

3. It occurs in all races and is more frequent in children during the first five years of life.

4. In spite of antitoxin treatment, the mortality is higher than in other countries, which condition may be due to a greater prevalence of laryngeal cases.

5. Post-diphtheritic paralysis is not of frequent occurrence, and our data regarding it are meager and incomplete.

We desire to acknowledge our appreciation of the courtesy of Drs. Florentino Ampil, H. W. Wade, and José Albert in placing at our disposal the records of San Lazaro Hospital, of the pathological department of the University of the Philippines, and of the pediatric department, Philippine General Hospital, respectively.

REFERENCES

1. BROWNLEE, J. Statistical studies in immunity. Journ. Hyg. 5 (1905) 514.
2. DEL ROSARIO, S. V. Report of the Philippine Health Service for the year 1917, page 63.
3. HIBBARD and BURROWS. Cited by W. P. Northrup in Nothnagel's Encyclopedia of Practical Medicine. American edition, Philadelphia (1902).
4. KOLMER, J. A., and MOSHAGE, E. L. A study of various methods for determining the virulence of diphtheria bacilli. Journ. Inf. Dis. 19 (1916) 1.
5. OSLER, WM. The Principles and Practice of Medicine, 8th ed., New York (1917) 61.
6. PARK, W. H., and BOLDUAN, C. The Bacteriology of Diphtheria. Edited by G. H. F. Nuttall and G. S. Graham-Smith, Cambridge (1908) 589.

# THE PHYSICIAN AND THE LABORATORY [1]

By Maj. J. E. Ash

*Medical Corps, United States Army*

Mr. President and Gentlemen: I am very sorry indeed that I cannot bring to you some epoch-making discovery which you might have taken back to your practices and by it wrought miracles on your patients. But this is not even to be a formal paper on a scientific subject, but more in the nature of a one-man debate on the relation of the physician and the laboratory to each other. By physician I mean just plain doctor—that ancient and honorable institution, the general practitioner—and please remember that by laboratory I mean the so-called clinical laboratory and not the institution for scientific research; the latter needs no argument or defense. I know that the unthinking and superficial consider it unnecessary and are apt to look with more or less contempt on the patient and unselfish worker who devotes his time to such apparent trifles as counting the scales on the backs of fleas. But this contempt must change to gratitude when this very information comes to have an important bearing on the study of the relation of the despised flea to still more despised diseases.

While essentially a laboratory man—and despite appearances I have had considerable experience in clinical medicine and, through the laboratory, have had the opportunity of observing the work of a great many physicians, specialists and general of all classes, from the best in astute Boston to the worst in cruder parts of the country—and while I have not as yet reached the age of the reminiscent, nor can I afford to do only abstract philosophizing, yet the dual experience has given me the opportunity of observing on the one hand the shortcomings, weaknesses, and successes of the doctor, and on the other the value as well as the limitations of the laboratory in its relation to the practice of medicine, and it has given me a broader perspective of these relations than is possible with a more highly specialized experience. It is some of the thoughts and questions

[1] Presented by permission of the Department Surgeon, U. S. Army, Philippine Department.

that have been roused by these observations that I wish to present and I can assure you that I am impartial, and without prejudice for the one side or the other.

The first and most pertinent question is, of just how much benefit is the laboratory to the practitioner? My unequivocal answer is that, to a man who knows enough medicine to practice it conscientiously, its value is in direct proportion to the degree of his independence of it. In other words, if he is a good man he knows when and how to call on the laboratory, and it is under these circumstances that the relations between the two are the best, and least liable to lead to disappointment. I mean to state that, particularly among the younger men and the careless older ones, there is a great tendency to depend too much on the laboratory for diagnoses and to substitute, for the time-consuming, careful study of the patient and the skilfully applied principles of physical diagnosis, a dogmatic report from the laboratory. To my mind there are two factors responsible for this. In the case of the young doctor, it is the fault of the school, where the laboratory work is necessarily very much emphasized, so that because of the lack of proper coördination between this and his clinical studies, he comes to have an exaggerated idea of its importance. This is more truly the case in the larger schools than it is in the smaller, the object in the latter being to turn out good, practical doctors and not highly trained scientists. I have seen second-year medical students so intent on doing research and turning out some "Arbeit" that they have lost their perspective and held in contempt the experience of the older man who is plodding along by the bedside. There is still room for question as to the advisability of allowing undergraduates to become engrossed in research, for this very reason, except in so far as it is valuable as a feature in the training of their powers of observation and inquisitiveness, and thus strengthening their foundation, rather than having it end as research per se. In the case of the older man, he has taken up the laboratory just as he has any other fad in medicine and particularly so, for in it he sees a way to save time and energy, even though it be at the patient's expense, both monetary and otherwise; and so both classes have neglected the development of the art of medicine or allowed it to slump, and have come more and more to depend on the laboratory to take the place of neglected God-given powers of observation and study. There comes to be a tendency to let George do it, George in this case being the laboratory. The doctor will have a case that may not be obvious to the superficial examination he is willing or able to give it, so he sends some blood or urine or feces, or maybe all of them, to the laboratory in the hope that a positive report of something or other may be forthcoming and on that report he will pin his faith and it will constitute the basis for his handling of the case without further particular study on his part. Why should he worry further about the diagnosis? Did the laboratory not report a positive Wassermann? "My duty, therefore, ends in a course of treatment for syphilis," he argues. The pathologist says the hemoglobin is low. "Why worry about the possibilities? I'll just give some iron or tonics." Hookworm eggs were found. "That simplifies things considerably. I can kill the worms and all will be well," he says, not stopping to think that perhaps the pathologist has been particularly diligent and has spent a great deal of time in finding one or two ova and that, while hookworms are not particularly desirable guests, one ovum in the stools no more makes a case of ankylostomiasis than one swallow makes an inebriate. The evil of the laboratory, therefore, is to dull the natural senses of the doctor and develop in him a false sense of security and a degree of dependence that is not healthy.

Can the doctor interpret the reports he receives? This is a very important phase of the question. Does he know enough about laboratory work to appreciate its limitations? Does he know the grade of work, the extent of experience, training, and honesty of the man who is doing his work? Or is he satisfied to receive a piece of paper that has on it something definite that he can show the patient, without regard to its accuracy? Much depends on these factors and they must be seriously considered by the clinician. It is as much an obligation on the doctor to select the right laboratory as it is to choose the competent surgeon or other specialist, for the patient depends on his judgment as much in the one instance as in the others.

Granted the doctor knows when to call on the laboratory for help, and granted that the laboratory work he is getting is dependable, can he, as asked before, properly interpret the reports he receives and give them their proper significance? It is here particularly that there should be close coöperation between the two. I claim that the pathologist should know enough clinical medicine to appreciate his relations to it. He should be more than a mere technician. He cannot report intelligently unless he has a broad grasp through knowledge and experience of the clinical side of the case, and can discuss the pros and cons intelligently with the clinician.

You must appreciate that it is not always possible to give a cut-and-dried report on a specimen. It is not much more possible to do this than it is for you to give the dogmatic diagnosis that your patient demands. We cannot always be dogmatic and accurate at the same time. It is often necessary to qualify the laboratory diagnosis, just as it is necessary for you to qualify and hedge on your clinical opinion of the case, often, and I might say usually. With some knowledge of the case the laboratory can often suggest an appropriate examination to be applied. I know that the chief reason for keeping the case a secret from the pathologist is to prevent a prejudiced or doctored diagnosis, but the danger from this is more than compensated for by the more intelligent examination and the benefit that the closer coöperation is bound to have on the outcome of the case.

Does the physician further know enough about a laboratory to enable him to send his specimens in proper condition? Does he know that a hemolyzed or old infected serum is not satisfactory for the Wassermann test and will probably be anticomplementary; that a cold stool is unsatisfactory material in which to find amœbæ; that a cell count on the spinal fluid must be done at the bedside to be at all accurate; that hyalin casts will disintegrate in an old specimen of urine? The responsibility for accurate laboratory work is not entirely with the pathologist.

The laboratory has very distinct limitations that you must realize. It cannot manufacture a diagnosis for you out of whole cloth, nor can it always make its findings fit in with your idea of what they should be. It cannot take the place of skilful and careful bedside study. You must realize that a negative report does not as a rule mean very much. Of course its significance is in direct proportion to the skill and care of the man who makes it. A negative report is usually very unsatisfactory to both the doctor and the pathologist, because it does not help the former very much and means a great deal more work for the latter. You know, the pathologist develops a sort of perverted moral sense. A positive specimen usually gives a peculiarly devilish sort of satisfaction to him, despite the meaning it may have for the poor patient. There is a certain amount of glee attached to finding tubercle bacilli in the sputum right off the bat, or being able to demonstrate amœbæ in the stool simply by focusing the microscope. For this spirit, of course, we owe the patient an abject apology. A negative report should not always be considered conclusive. It requires persistence and a certain amount of luck, and sometimes repeated examinations, to exclude that particular factor, especially if the clinical picture is insistent. Given a primary sore of syphilis, you must remember that a certain time must elapse before the Wassermann test will be positive and that a negative dark field finding in such a sore that has been receiving local treatment means practically nothing. The albumin is not constantly present in a case of chronic nephritis; a drink of whiskey taken a few hours before blood is drawn for the Wassermann may render an otherwise positive serum negative. The spinal fluid in meningitis does not always give the picture it should. Therefore, the negative report must usually be considered with more than a grain of salt.

What, on the other hand, does a positive report mean? Is it really the key to the case, or does it merely speak for an intercurrent condition that may have little bearing on the symptoms at hand? The interpretation, therefore, of the laboratory findings and their proper application are very important features of the relation between doctor and laboratory. My pride has often received a jolt when I have been forced to realize what an unimportant part the laboratory has played in the study of a particular case. In following such cases through their course, even to death and autopsy, with the organs spread before us in plain view on the table, the answer has still been hidden from us, and we could but throw up our hands and realize how little after all our knowledge really is of those essential vital processes that differentiate us as kings of the earth from hulks of clay.

I have been pessimistic enough, for there is much good in the laboratory. We think of the wonderful old stars of our profession, those pioneers who toiled so skilfully and painstakingly in so much medical darkness, and we marvel at the results they attained. The elder Gross did not need a modernly equipped laboratory with a trained pathologist to diagnose cancer of the breast for him; Hunter knew nothing of those peculiar biological properties of the blood serum that were later to be harnessed in the complement fixation test for syphilis, but he usually knew a hard chancre when he saw it. These men used to the utmost the things they possessed. They observed and remembered. I present these and the other staunch pillars of the past as my chief argument for the proposition of the great need of cultivating as much independence of the laboratory as possible. But these men were wonderful and did great things, and we do not detract from their greatness by suggesting how much greater they would have been in the present day with its increased advantages and with the aid of modern diagnostic methods. It only serves to emphasize how much greater your responsibilities are to-day. You have the same opportunity to develop the powers that lie within you; greater, for they have broken the ground for you in many places. In addition you have the new things. The value of modern methods cannot be denied. How many cases of so-called latent syphilis did the great Hunter miss? There have been untold numbers maltreated for malaria simply because the diagnosis was unaided by the blood examination and the clinical picture was all they had to depend on. On the other hand, there has been many a case of atypical malaria go down without the benefit of specific treatment because they did not know that the disease had a more definite and tangible etiology than the mysterious miasm that arose with the damp night air from marshy places.

I am not particularly enthusiastic about haphazard routine examinations, not so much from the clinical side as from the demoralizing effect they are apt to have on the laboratory. This applies more especially to hospitals, of course. Large numbers of routine examinations may lead to carelessness and superficiality. But even so, conditions are often picked up during such examinations that would otherwise have been overlooked and have remained hidden, so we must look on them as necessary evils. There are certain things you should know about your patient, no matter how obvious the conditions may seem. In this day it is much safer to assume everybody syphilitic until proven otherwise, no matter what his or her civil, social, or sexual state. You should know the condition of the urine as a matter of routine, and in this part of the world, where parasitism is so common, this should be always eliminated in its various common possibilities. There have been many cases of chronic amœbic dysentery operated for appendicitis. But it is not necessary to dwell on the possibilities of the obscure and misleading symptoms that are at times manifested by the various parasites; you are more familiar with them than I am. Nor is it necessary for me to detail further the great benefits that are to be derived from the sane and intelligent use of the laboratory. You cannot practice medicine in this day and generation without recourse to the laboratory.

The general principles that I wish to advocate are these:

1. That it is a greater crime to neglect these benefits than to overindulge them.

2. That there must be the closest coöperation between clinician and pathologist.

3. That the clinician must be familiar with laboratory work to the extent of knowing how, when, and where to depend on it, and the pathologist must be sufficiently experienced in clinical matters to handle intelligently the materials submitted to him; and lastly, I have argued myself, and I hope you also in a measure at least, to the conclusion that the physician does not do full justice to his patient until he has developed to their fullest possibilities the natural powers of observation, has exhausted these on the bedside consideration of the case and then, and only then, given him the full benefit of the aid the laboratory can be in corroborating, elaborating, or eliminating his conclusions. Under these circumstances will you come the nearest to the proper solution of the problem—the diagnosis and treatment of the condition for the relief of which the patient has entrusted himself to your care.

# NOTE ON THE KEEPING QUALITIES OF DRIED AND PULVERIZED VACCINE VIRUS

By Dr. O. Schöbl

At the request of the Philippine Health Service, some experiments were made at the Bureau of Science in order to ascertain the method of preparation, and the means of preservation, of dried vaccine virus for practical purposes. The proper distribution of active virus to remote places has always been a problem in the Philippines, on account of geographical conditions, particularly in case of emergency—that is, when smallpox breaks out in a far-away place—because it takes a long time for the vaccine virus to reach its destination. Furthermore, we must take into consideration that there are localities in which there is no way of keeping the glycerinized vaccine virus at low temperature during shipment from the nearest port to these remote places.

It seems, therefore, that it is of great importance to the sanitary authorities of this country to try to distribute vaccine virus in such form that it can be kept even under unfavorable conditions; in other words, in a form in which even if direct light, and sun heat or artificial heat are excluded, the vaccine can still be kept for a reasonable length of time. Were this possible vaccinations could be performed in the interior of islands where communication and ice plants are nonexistent. It would also benefit parts of the Islands which have both communication and ice, in as much as the health officer located in such places could keep on hand a certain amount of vaccine all the time, and if smallpox should break out in his district vaccinations could be commenced within three hours after receiving the report of the first case of the disease in the district. There are no doubt places connected with Manila, but where connection is such that, even if the health officer cable immediately for vaccine virus, several days, and probably a week, must elapse before the required amount can reach him.

In looking over the literature on the subject, we find very few references. Apparently in most countries which have direct communication by land the vaccine virus preserved with glycerine is satisfactory for any occasion, and no further steps need be taken for the preservation of this important biologic product. In searching for data concerning the dried pulverized vaccine, we have to go back in the literature to 1881 to find the first note on the subject. Reissner in Darmstadt, and Frappoli in Italy, appear to have been the first ones to experiment with the drying of vaccine virus. It was at that time that the preservation of vaccine virus for wide distribution and shipping was desirable; but the glycerinized vaccine virus, as introduced by Muller about the same time, became supreme, and was so satisfactory that no further attempts were made to dry the vaccine virus. As far as the Philippine Islands is concerned, we find a note on the "Preservation of vaccine virus" by E. H. Ruediger in the Bulletin of the Manila Medical Society, August, 1910.

In preparing dried vaccine naturally three requirements have to be fulfilled. First, the drying must take place as rapidly and as completely as possible, and without the application of artificial heat. Second, the preservation must be such as to keep the powder in absolutely dry condition; it must be kept away from light, particularly sunshine, and from heat. Third, the bacterial content of the dried vaccine must be considered; in the absence of glycerine, which in the glycerinized vaccine acts not only as a preservative but also as a bactericide, the bacterial content in the dried vaccine will naturally be higher than in the glycerinized vaccine.

## EXPERIMENTS PROPER

The vaccine was prepared in the following way: The pulp obtained by scraping a vaccinated animal was ground up in a sterile mortar, spread over a large surface under aseptic conditions and dried rapidly over a hygroscopic chemical in vacuum, ground up, perfectly dried, and kept in a desiccator at room temperature. Every week one monkey was vaccinated with a small portion of this powder and kept under observation in order to ascertain whether or not there was any difference in the development of the "take" in this monkey and that of another one, used as control, which had been inoculated at the same time but with fresh glycerinized vaccine. Up to date of writing, that is, four months from the time the vaccine was prepared (and it was kept at room temperature all the time), we have obtained in all inoculated animals first-class "takes" which could not be distinguished from the "take" in the control animal inoculated with fresh vaccine. We cannot, therefore, at the present writing state definitely how long the dried and pulverized vaccine will keep. But, in view of the fact that the experiments showed good results during the past four months, the procedure seems to be of practical use.

In order to make the use of this vaccine as simple as possible, we have suggested that it be put up in ordinary straight, one cubic centimeter, amber glass vials with rubber stoppers sealed with paraffine, another vial of the same type to contain the glycerine necessary to dissolve the powder immediately before use. The vial is opened by removing the rubber stopper. The glycerine is poured into the vial containing the powder. The rubber stopper is tightly replaced and the contents are shaken for several minutes until the powder has mixed with the liquid. This simple and convenient way of putting up the dried vaccine may not be the best as far as preservation of the dried vaccine is concerned; sufficient moisture may penetrate into the vial to render the vaccine virus inert in less time than four months. It was therefore suggested that, in case the above-mentioned method will not give satisfactory results, the powder be kept in hermetically sealed ampules, or be kept on hand in open bottles placed in a small desiccator containing a hygroscopic chemical.

Besides the experiments already mentioned, we have arranged a field experiment by shipping dried vaccine virus to various places in the Archipelago and back, and then testing its activity on monkeys by vaccination. The places to which dried vaccine was shipped and tested when returned to Manila are: Currimao, Ilocos Norte; Pandan, Ilocos Sur; San Antonio, Zambales; Calapan, Romblon, Pasacao, Culion, Surigao, and Butuan; Cagayan and Iligan; Oroquieta and Dapitan; Zamboanga, Jolo, Cotabato, Quinimi, Glan, Davao, Agutay, and Cuyo. The length of time necessary for shipping and reshipping was twenty-five days. The animals vaccinated with these dried vaccines showed first-class "takes."

The process of drying the vaccine pulp seems to decrease its bacterial content. In the experiments above mentioned the bacterial content decreased three hundred sixty times during the process of desiccating.

It is hoped that this preparation will help a good deal in overcoming some of the difficulties with which health officers meet in eradicating smallpox in the Philippines.

# VENOM OF THE PHILIPPINE COBRA (ALUPONG) NAJA NAJA PHILIPPINENSIS

By Drs. C. Monserrat, O. Schöbl, and L. E. Guerrero

The present paper is but a short review of certain investigations which have been conducted by us in the Bureau of Science.

Because of the fact that we are dealing with a snake widely distributed in the provinces of the Archipelago, and because of the belief that it is one of the most poisonous among our native ophidians, we thought it best to study the biologic properties of its poison to gain an idea of its toxic and hemolytic powers, and to attempt to produce a true antiserum which would neutralize its deleterious effect on the organism.

It is generally believed that there exist in the Philippines very few species of poisonous snakes and that the mortality due to snake bites is negligible. Both Griffin and Taylor have disproved this belief by showing that there exists in the Philippines a considerable number of more or less poisonous species of snakes. Of these, the cobra is the most widespread and the one which is probably responsible for the majority of deaths due to snake bite.

Catanjal in a paper published in 1912 claims that in the Philippines eighty-six persons died in 1909 of snake bite. These deaths occurred in fourteen provinces. The distribution is evident from the following table:

| Province. | Cases. | Province. | Cases. |
|---|---|---|---|
| Albay | 9 | Isabela | 1 |
| Ambos Camarines | 1 | Laguna | 3 |
| Batangas | 13 | La Union | 2 |
| Bohol | 2 | Misamis | 1 |
| Cagayan | 3 | Nueva Ecija | 6 |
| Ilocos Norte | 18 | Pangasinan | 16 |
| Ilocos Sur | 5 | Tarlac | 6 |

Catanjal figures that 3.14 per cent of the deaths in these fourteen provinces were due to snake bite, basing his figures on the data of the 1903 Census. Further statistics of the Health Service during the period between 1913 and 1918 show 847 deaths from snake bite, an average per year of 141.17 deaths. This is 1.41 per each 100,000 inhabitants, taking as a basis a population of 10,000,000. The number of deaths by years occurred as follows:

| Year. | Deaths. | Year. | Deaths. |
|---|---|---|---|
| 1913 | 78 | 1917 | 133 |
| 1914 | 163 | 1918 | 168 |
| 1915 | 162 | | |
| 1916 | 143 | Total | 847 |

This snake, known by the native names of *alupong* and *alimuranin,* belongs to the genus *Naja* and was until recently considered to be identical with the species *Naja caeca* and *N. sputatrix;* but investigations of Taylor, of the Bureau of Science, showed that such classification was erroneous because of the differences in characters, such as color, and number and distribution of scales, which exist in the Philippine species as compared with other members of the family. For this reason the Philippine cobra was classified by him as a distinct subspecies, *Naja naja philippinensis.*

## COLLECTING COBRA VENOM

The poison was obtained from live anæsthetized cobras by pressing the glands with the fingers, the venom being allowed to run down the fang into sterile vials. The fresh poison is a thick, sirupy, colorless liquid of opalescent aspect. When desiccated in vacuo it forms small yellowish flakes. The amount of poison which we obtained from an adult *Naja naja philippinensis* at any one time weighed approximately 0.052 gram after drying.

## BIOLOGIC PROPERTIES OF PHILIPPINE COBRA VENOM

### I. TOXICITY

The minimum lethal dose of the venom has been ascertained for the following animals: Guinea pigs, rabbits, monkeys, and frogs. Of these the most susceptible is the monkey, and the most resistant is the frog.

The minimum lethal dose for a guinea pig in twenty-four hours after subcutaneous injection is 0.0002 gram per kilogram of body weight, while that for a rabbit is 0.0003 gram; for a monkey, 0.00008 gram; and for a frog, 0.0005 gram.

Calmette found the minimum lethal dose of the venom of *Naja tripudians* for guinea pigs, when administered subcutaneously, to be 0.0004 gram per kilogram of body weight, and Noguchi found it to be 0.0005 gram.

When injected per venam in rabbits it was found by Calmette to be 0.0005 gram per kilogram of body weight; and by Lamb, 0.00035 gram. Lamb gives 0.00025 gram as the intravenous lethal dose for monkeys.

Comparing our figures with those arrived at by other workers, it seems that the venom of *Naja philippinensis* is considerably more toxic for the lower animals than those studied elsewhere. For man the lethal dose of Indian cobra venom was estimated by Lamb at from 0.015 gram to 0.0175 gram, for a person of from 60 to 70 kilograms of body weight, his conclusions having been based on his experiments with monkeys.

Assuming the resistance of man to cobra venom to be intermediate between that of the monkey and the rabbit, we can estimate the minimum lethal dose of the Philippine venom to be about 0.00019 gram per kilogram of body weight, or from 0.0095 gram to 0.0114 gram for a person weighing from 50 to 60 kilograms, the approximate average weight of Filipinos. Therefore, the amount of venom a single alupong possesses, which is estimated to be 0.052 gram, would suffice to kill five persons of 50 kilograms weight.

## II. SYMPTOMS OF COBRA VENOM INTOXICATION

The symptoms generally observed in the experimental animals are as follows: Twitching of the lids, ears, and sometimes of the muscles of the body; excessive salivation, nausea, and vomiting; loss of voice, rapid respiration, and drop in temperature. We also observed lacrymation and a very marked ptosis of the upper eyelids, especially in monkeys.

From the very beginning there is great weakness. Emission of semen and involuntary defecation take place immediately before death. Death is caused by the cessation of respiration first, while the circulation is affected later.

## III. HEMOLYTIC PROPERTIES OF THE VENOM

Though the toxicity of the venom of our *Naja* has been found to be somewhat higher than that of the other species of the same genus, its hemolytic power according to our observations is slightly lower.

The venom of *Naja philippinensis,* like that of *Naja tripudians,* can hemolyze washed red corpuscles of man, dog, rabbit, and guinea pig, but cannot hemolyze the erythrocytes of sheep, goat, and cow. These differences are, of course, only quantitative.

The activating power of blood sera of certain vertebrates for the hemolysins contained in the Philippine venom is analogous to that described in the case of *Naja tripudians,* except that larger amounts of the sera are necessary to produce the same result.

Lastly, the venom of *Naja philippinensis* hemolyzes equally the defibrinated and the washed red blood cells of monkeys.

## PREPARATION OF SERUM

Following the procedure of Calmette, we used horse for the preparation of antivenom serum. According to this investigator the fatal dose of cobra venom in twenty-four hours for this animal is 0.025 gram. The immunization was begun with a dose amounting to one thousandth part of the fatal dose for the horse.

The injections were made subcutaneously at intervals of from five to seven days, increasing the dose each time. We used the desiccated venom dissolved in salt solution.

Altogether, the horse was under treatment for a period of about ten months, after which time the injections had to be discontinued on account of lack of venom due to the death of our cobras.

We started injecting the horse on May 23, 1918, and by September 11 it was receiving 0.1 milligram of the venom in each injection. On September 12, 10 cubic centimeters of blood were withdrawn from the animal for the purpose of determining the antitoxic power of the serum. In the experiment four guinea pigs weighing from 250 to 450 grams were used. Varying quantities of serum were used (0.2 to 1 cubic centimeter) with a double lethal dose. The result was negative in that all the guinea pigs died within twenty-four hours.

By November 20 of the same year, the horse reached the dose of 2 centigrams of the venom, and six days later another 10 cubic centimeters of blood was taken and the serum again tried on the guinea pigs. The results were again unsatisfactory, since both protected and control animals died, though protected guinea pigs survived the controls by three days.

On January 13, 1919, the horse reached the dose of 12 centigrams of the venom in one injection. The following week blood was obtained and the serum tested on guinea pigs as before. The results this time were satisfactory. The animal that received 2 cubic centimeters of the antivenom serum survived the two control animals.

On April 7, 1919, the horse reached the highest dose of the venom, that is, 0.1555 gram. A few days later, the animal was bled 5 liters of blood. The serum thus obtained was tested for its preventive neutralizing and curative value.

According to our experiments the neutralizing value in vitro was estimated to be 0.4 cubic centimeter for guinea pigs of 400 grams body weight.

This quantity of serum, mixed with a lethal dose of the venom at room temperature for one hour and injected subcutaneously, saved the animals, while 0.6 cubic centimeter of normal horse serum, mixed with the venom as a control under the same conditions, resulted fatally to the experimental animal.

The therapeutic power of the antivenom serum was tried on rabbits. We found that 1 cubic centimeter of the serum injected intravenously saved a rabbit of 1 kilogram body weight from a sure lethal dose of cobra venom.

The effect of the serum as a preventive or curative in case of snake bite in human beings has not been ascertained up to the present. It is the intention of the authors to distribute this serum to provincial physicians who are interested and willing to supply us with information concerning the kind of snake, location of the bite, and also the symptoms of bitten patients. It must be remembered that, in case of cobra bite, death may and very often does occur within a few hours after the patient has been bitten. It would, therefore, be impractical to defer request for a supply of the serum until the snake bite occurs. On the other hand, the care of the liquid serum demands certain equipment, such as an ice box, which a good many of the provincial physicians may not have at their disposal. It is claimed by various authors who have used this serum in other countries that its antitoxic power will remain practically the same for a considerable length of time. Nevertheless, in the absence of proper precautions, contamination may take place which would not only deteriorate the serum but also injure the patient upon injection. We are, therefore, arranging experiments to preserve the serum in dry form in which condition it is analogous to other antitoxins. Preserved in properly sealed ampules the serum will keep almost indefinitely. The dried scales of serum in one vial, and carbolized distilled water in another, has been found satisfactory and most economical for dispatching the serum to physicians, instructions being given that 10 cubic centimeters of the serum be injected subcutaneously as a preventive, and 20 cubic centimeters in case symptoms of snake-bite poisoning have already set in. Another injection of 20 cubic centimeters should be given if satisfactory improvement of the patient's symptoms has not taken place in two hours after the first injection. Injection should be given as soon as possible. The place of the bite should be opened by incision and a ligature should be placed rather tightly on the proximal end of the extremity above the place of the bite. To avoid formation of gangrene the ligature should not be allowed to stay too long. The incised bite should be thoroughly and repeatedly washed with oxidizing agents (permanganate). The patient should be placed in a quiet, dark place and be given stimulants. In the absence of other stimulants, hot strong coffee should be used. The respiration should be carefully watched and artificial respiration induced in case the natural respiration becomes weak.

It is hoped that in the future it will be made possible to produce larger quantities of serum than has been possible so far. The authors will highly appreciate it if physicians throughout the country will send information as to the possibility of catching live cobras and shipping them to the Bureau of Science, so that a sufficient amount of poison can be collected for the immunization of horses.

# CLINICAL FORMS OF PANOPHTHALMITIS OBSERVED IN THE PHILIPPINE GENERAL HOSPITAL

By Dr. A. R. Ubaldo

Very little has been written with regard to panophthalmitis in the literature of the past years. Altogether seventy cases have been observed in the Philippine General Hospital during the period from 1917 to 1919—twenty-one in 1917, twenty-one in 1918, and twenty-eight in 1919. These cases of panopthalmitis ended in total blindness, and this disease is responsible for the greater percentage of blindness caused by ocular diseases.

Inflammation of the eyeball, in which the infection is localized, may start from the anterior chamber and extend to the posterior and to the vitreous, involving the neighboring structures of the uveal tract, choroid, and retina. All of this constitutes what we call panophthalmitis. In fewer words, panophthalmitis is inflammation of all the structures of the eyeball.

Inflammation in such cases is produced by infection, which may have two ways of gaining entrance into the eye; namely, infections coming from the outside, as in all cases of traumatism of the eyeball, perforating ulcers with rupture of the eyeball, etc., known as ectogenous in origin; and internal infections, or infections conveyed to the eye through the circulating blood as in septicæmia, pyæmia, and suppuration of other structures, which are known as endogenous in origin; and in such infections the eyeball appears to be intact and without rupture.

## BACTERIOLOGY

The microörganisms found are very numerous, but the most frequent are: Staphylococcus, streptococcus, pneumococcus, *Bacillus xerosis, Diplobacillus moraz* Axenfeld, *Bacillus subtilis,* and *Bacillus pyocyaneus.*

Infections of the cornea by pneumococcus and diplobacillus were the cause of most of the cases of ulcus serpens. Out of eighty-five cases of hypopyon keratitis examined by Axenfeld, fifty-five were caused by pneumococcus and twenty-five by diplobacillus.

Staphylococcus, streptococcus, and *Bacillus subtilis* are mostly found in traumatic wounds.

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## ETIOLOGY

I have divided my cases according to the causal factor, as follows:

Infection from corneal ulcers (perforating or otherwise), where the traumatism was due to leaves of plants, 15 cases.

Infection originating from traumatisms, such as wounds (perforating or contused) caused by dust, foreign bodies, etc., 10 cases.

Infection from inflammation of old lesions, as in leucomas, staphylomas, exposure of the eye in facial paralysis, exophthalmic goiter, etc., 10 cases.

Infection from internal causes, that is, endogenous in character, or from some unknown origin, 35 cases.

In the first group occurred several cases of traumatic ulcers of the cornea produced by rubbing of leaves of rice, grass, hemp, the sharp edge of buri, or pineapple leaf, and corneal ulcers from dacrocystitis, trachoma, gonorrheal ophthalmia, etc.

The second group includes perforating wounds of the cornea due to sharp-pointed bodies such as nails, bamboo sticks, finger nails of a child, cinders, dust, or other foreign bodies rubbed into the cornea and producing ulcus serpens. One case of panophthalmitis (the municipal treasurer of Marilao) showed hypopyon within the first forty-eight hours. Among other cases included in this group were those produced by the removal of foreign bodies from the cornea by inexperienced persons; one case from a blow from the horn of a carabao; one due to a blow received during a fight; another case was hit by a stone, and some others were caused by gunpowder explosions near the face, or by small shot hitting the eyes. Some of the cases in both first and second groups showed an accompanying chronic dacrocystitis.

In the third group are cases that occurred as the result of inflammation of old lesions, as in leucomas, staphylomas following smallpox, etc. There are also included here cases resulting from the exposure of the cornea to dryness consequent upon facial paralysis or exophthalmic goiter, in which the lids could not be closed.

In the fourth group, the panophthalmitis was secondary to a local infection outside of the eye, as in pyæmias. In two children, staphylococcia following pustules of the scalp occurred and gave rise to metastatic panophthalmitis. A case of metastatic choroiditis following abscesses of the arm and chest occurred in an old woman, 55 years of age.

## SYMPTOMATOLOGY

In most cases the loss of vision was more or less complete, with pain and tenderness in the eyeball, lachrymation, and photophobia. As objective symptoms there were redness of the eye, swelling with more or less complete closure of lids, conjunctivitis, congestion and œdema of the conjunctiva, keratitis, hypopyon, some discharge, and opaque cornea.

A case is on record of fatal streptococcia with panophthalmitis, in which the patient was suffering from acute rheumatism. Blood cultures were positive for streptococcus. De Schweinitz also reported a case of bilateral metastatic ophthalmitis in puerperal pyæmia, with recovery of the patient but with loss of vision in both eyes. Bacteriological examination of the conjunctival secretion showed the streptococcus pyogenes.(1)

I also had a very good case of metastatic panophthalmitis or choroiditis in an old woman, 55 years of age, who was suffering from multiple abscesses of the left arm and chest. By a coincidence, the left eye was the one affected. The affection began by immobility of the iris, dimness of vision, whitish lens, and later pain in the left side of the face and chemosis of the conjunctiva, followed by extensive œdema of the lids, and the iris could not be dilated with atropin. In less than a week the condition became markedly worse; the œdema of the lids was so bad as entirely to preclude their opening, even with the help of lid retractors. The size and tension of the eyeball increased, and clear symptoms of panophthalmitis became evident. Enucleation confirmed the diagnosis, considerable turbid matter exuding from the removed eye.

The symptoms of the traumatic cases were different. There was a case of a perforating wound of the cornea due to trauma by a piece of sharp-pointed stick of bamboo, which affected even the iris. However, the patient could still count fingers. The wound was apparently closed and there were signs of only mild inflammation of the eye.

## TREATMENT

When we have before us a case of an injured eye, the first question which comes up is, whether the wound is perforating or not. The next question is, whether the wound is infected or not. When infection with suppuration is present, one must determine whether the suppuration is localized in the anterior chamber or has extended to the vitreous. These are the problems before the specialist.

Another very important phase of the question which the physician must decide, and which requires the exercise of careful judgment, is whether or not he shall advise removal of the eye, knowing as we do what a great sacrifice such a step would mean to a patient. There are cases where the patient can recognize objects quite well and with only slight pain in the affected eye; but, with the affection extending to the ciliary region, and with great danger of sympathetic ophthalmia, in such instances would the patient submit to removal of his eye as advised by his physician?

When we are therapeutically powerless, we resort to surgical means and advise operation. Saemisch incision, corneal paracentesis, enucleation, and evisceration are the main operative measures generally followed.

Evisceration and enucleation have been performed with about the same frequency in our cases. In our practice, we have preferred to perform enucleation in the less-infected cases, and evisceration in the most septic. In our experience, the time of postoperative treatment in enucleation was considerably less than in evisceration, the former taking an average duration of from one to two weeks to make a good recovery, while the latter required about three to six weeks.

As to the proper time when enucleation should be performed in cases of panophthalmitis, it is interesting to note the experience of Professor Hook,(3) of Zurich, who reports 118 enucleations for panophthalmitis of different origins and in various stages, without registering a single case which showed an unfavorable course.(2)

There is very little danger of intracranial extension of the infection, and no complicating cases of meningitis, even in the severest types of panophthalmitis in which enucleation was performed, have been reported.(3)

Both enucleation and evisceration have their individual advantages and disadvantages, their advocates and foes; and, while enucleation is performed more frequently than any other method of operation, yet the wisest surgeon is he who would utilize the operation best adapted under existing circumstances to his cases.

Many surgeons feel that evisceration is probably safer than enucleation in panophthalmitis. There was one instance reported by De Schweinitz of an interesting case of panophthalmitis, which, after a careful evisceration, developed severe pain in the operated eye, that became so unbearable as to require enucleation, and microscopical examination after the second operation showed uveal tissue that had not been removed. (4)

In our series of enucleations we have followed two methods; by the one method we sutured the rectus muscles and closed up the conjunctiva, and by the other we left the conjunctiva open without suturing the ends of the rectus muscles, making however proper provision for drainage. The results have been satisfactory so far as the recovery of the operated eye was concerned, the time required for postoperative treatment was shorter, and the recoveries uneventful.

Those who advocate evisceration do so on the ground that removal of an eye in the presence of panophthalmitis means exposure to complicating septic meningitis or cellulitis. We have been very fortunate in our cases in escaping such complications or accidents. We have performed twenty enucleations and thirty eviscerations in this series; and from 1911 to 1919 there were one hundred seventy-nine eviscerations and one hundred forty-seven enucleations performed at the hospital.

### REFERENCES

1. Annals of Ophthalmology (1912).
2. Am. Journ. of Ophthal. (1919).
3. Ophthalmology, Essays, Abstracts and Reviews (1911).
4. The American Encyclopedia of Ophthalmology.

# CORNEAL PARACENTESIS

By Dr. Herminio Velarde

Traumatic injuries to the eyes are very frequently observed among the working class in this country. They are usually produced by direct traumatism, either by sticks or other sharp objects, or by the entrance of small, foreign bodies into the conjunctival sacs. Such injuries inflicted upon the corneæ, producing destruction of the corneal epithelium, are invariably infected by the numerous organisms present in the conjunctiva and especially in the diseased lachrymal sacs. They produce ulcus corneæ serpens with hypopyon and perforation and, invading the deeper and delicate structures of the eyes, cause iridocyclitis, uveitis, infection of the vitreous humor, and panophthalmitis. The usual termination is the total loss of vision and atrophy of the eyeball.

Many patients have come to the hospital with eyes completely destroyed, and either evisceration or enucleation is then imperative. It is certainly very sad that so many eyes have met their fate this way. It is for this reason, and because of so many apparently hopeless cases whose eyes have to be saved, that we are obliged to employ the different methods of treating them, including corneal paracentesis.

The operation which will be discussed with you to-day is not altogether a new one and, in fact, the opening of the anterior chamber of the eyeball was resorted to in ocular surgery long before the period of antiseptic medicine. It was probably first publicly recommended by Nuck in 1698. But due to many failures in those days, probably because of the lack of a proper knowledge of asepsis, the operation was abandoned, and in 1862 many surgeons, among them Sperine and Rigaud-Landrau, actually opposed the method. The English ophthalmologists were also against this method of treatment in those days, but later they accepted evacuation of the aqueous humor as the best treatment for inflammation of this region of the eyes, and in 1840 Mackensie, Middlemore, and Tyrrel made use of the method. Wardrop, in the Edinburgh Medical and Surgical Journal, recommended this treatment in all cases of hypopyon. Carel published an excellent article on the treatment of corneal ulcers with hypopyon by this method. This operation was, however, not made use of until Guthrie in 1884 (improved later by Saemisch) advocated the treatment, and since then different modifications of the original method have been used with more or less success. Thus I can give you an interminable list of prominent ophthalmologists of different nationalities giving testimony to the subject.

This report is based upon twenty-two cases admitted and treated in the department of ophthalmology, otology and rhinolaryngology in the Philippine General Hospital.

*Age.*—The age varies from 4 to 81 years. The majority of the cases however were 45 years of age.

*Sex.*—Almost twice as many males were affected as females, the relation being 14 males to 8 females. This greater percentage of males is explained by the fact that they are more exposed than are females.

*Etiology.*—In this series of twenty-two cases, the majority of cases of corneal infection were caused by traumatism through injuries of various kinds inflicted upon the corneal surface, which subsequently became infected, leading to most serious complications with disintegration of the corneal substance, panophthalmitis, and total loss of the eye. Such were the conditions of the patients admitted to the hospital; they were altogether too late for any satisfactory treatment.

The following table shows the etiological factors producing the eye lesions of the twenty-two cases we now have on hand:

| | Cases. |
|---|---|
| A. Corneal injury due to: | |
| Dust entering conjunctival sacs | 7 |
| Tail of fish | 2 |
| Sticks | 2 |
| Grass leaves | 2 |
| Leaf of rattan | 1 |
| Leaf of rice | 1 |
| Leaf of bamboo | 1 |
| Buri strip (dried leaf) | 1 |
| Tin can | 1 |
| Coconut shell | 1 |
| A piece of bone | 1 |
| B. Causes not well known by the patients | 2 |

As a rule these patients received the injuries to the eyes accidentally and while performing their daily duties of life. Those working on farms are more subjected to corneal injuries produced by leaves of grass, rice, and other plants, as shown by the three cases.

The case of a four-year old child, whose eye was hit by a piece of tin can while playing with other children, was purely accidental. The injuries caused by sticks, fish tail, coconut shell, buri strip, and a piece of bone were all accidental, not occupational.

The two cases who could not give a definite account of their eye lesions gave the history of getting up in the morning with their eyes red and painful. The condition got worse, and the cornea became white with definite signs of infection.

It is a very common practice among our masses to submit the injured eyes to various dangerous and unscientific procedures of the "herbolarios" and quacks who practice what is commonly known as "cahig." It is certainly surprising that in this stage of our national progress not only the poor ignorant ones submit themselves to these herbolarios (Chinese and Filipino quacks who employ unscientific manipulations), but also many of what we may classify as educated. I still from time to time meet a few cases of those who pour human urine into the eyes when they are infected. Much more frequently, however, we observe people instructing that human milk be dropped into the diseased eyes. These are among the many factors which contribute to making a slight injury to the cornea result in serious infection and, not rarely, terminating in total loss of vision.

The patients admitted to the hospital who were submitted to corneal paracentesis were nearly all advanced cases, having poor vision; most of them could only perceive light, while others had totally lost vision. They are as a rule left abandoned and the patients do not consult the physician until it is too late to carry out any satisfactory treatment. The following table shows the duration of illness of these patients:

| Duration of illness before admission to hospital. | Patients. |
|---|---|
| Less than one week | 2 |
| One week | 5 |
| Two weeks | 2 |
| Three weeks | 2 |
| One month | 4 |
| Two months | 1 |
| Three months | 1 |
| Five months | 1 |
| Nine months | 1 |

Judging from this table, nineteen cases had their eyes injured long before they came for hospital treatment. A few of them, however, consulted regular practicing physicians and eye specialists before admission. We should always take into account that traumatic injuries must be considered as emergency cases and, therefore, require immediate attention right after the injury. But, as a rule, these patients come for treatment too late and in very serious condition.

The following enumeration shows the degree of eye infection in these cases:

Three cases with total destruction of the corneal substance, with pus in the anterior chamber and involvement of the ciliary bodies, and with vision very poor and almost negative.

Eight cases with corneal ulcerations and beginning disintegration of the corneal tissues, with hypopyon, and only able to perceive light.

Six cases with corneal ulcers and hypopyon and able to count fingers at the average distance of three feet.

Four cases with superficial ulcers and hypopyon, and vision good except slightly impaired due to photophobia and lachrymation.

Thus, it will be seen that only four had fairly good vision, six could hardly see objects, and the rest could be considered as having totally lost vision.

## TREATMENT

*Preoperative.*—Patients are submitted to very little or practically no medical treatment. The bowels are opened regularly by cathartics, usually magnesium sulphate or magnesium citrate. If there is much pain in the affected eye dionin (one to two drops of 10 per cent solution) is administered once or twice daily, depending upon the severity of the pains. The eye is kept clean by antiseptic eyewashes and by the use of the silver compounds, usually nitrate (from 1 to 2 per cent), and iodoform powder. Simple, hot, moist compress, or with aluminium acetate well diluted, was applied to the eyes in acute cases, especially in those with involvement of the conjunctival lids. Urotropin, a 30-centigram capsule, was administered internally three times a day in all cases.

*Technic of corneal paracentesis.*—The routine preparation for a regular major ocular operation is made. The eye is put under a complete local anæsthesia with 10 per cent cocain solution, although in children and nervous patients, and in acute cases with acute pains due to increased ocular tension, general anæsthesia is used. (General anæsthesia was used in some of my cases, and local in others.) The lids are opened by a lid retractor, exposing the eyeball. The eyeball is held with a fixation forceps with the left hand. A narrow-blade, Graefe's cataract knife is introduced on the outer and lower quadrant near the limbus penetrating the anterior chamber. The knife comes out on the lower and inner quadrant near the limbus on the opposite side, producing an incision along the lower border of the cornea about 10 millimeters long, similar to a cataract incision. This produces an extensive area for drainage of the thick pus in the anterior chamber. By a careful manipulation with a small horn spatula, or with iris forceps, the contents of the anterior chamber are evacuated. This is later followed by washing the anterior chamber with 2 per cent boric acid solution, or sterile water, using a fine curved cannula until all pus and necrotic materials are removed. The ulcer of the cornea is cauterized with thermocautery. Atropin, one to two drops of 2 per cent solution, is instilled, and hot moist compress is applied.

*Postoperative treatment.*—The patients are treated at least once daily after operation. The eyes are examined and the dressings changed every day. Atropin is instilled whenever necessary. Special attention is given to the examination of the iris so that adhesions may not take place. Finely powdered iodoform is sprinkled on the ulcerated cornea whenever necessary. If pus forms again in the anterior chamber and its evacuation is necessary paracentesis of the cornea is again made.

*Result of the operation.*—The result of this treatment is very satisfactory. Of the twenty-two cases operated upon for corneal paracentesis two have completely recovered, nineteen were improved, and one was not improved at all by the treatment. The two cases of recovery left the hospital with perfectly normal eyes and normal vision. Of the nineteen improved, twelve cases have improved vision and the corneal lesions terminated in leucoma. Some of these cases can be submitted to iridectomy for artificial pupil, although they were then too premature to be submitted to such operation. Seven of the improved cases have negative vision with plastic iritis, seclusio et oclusio pupillae; but the corneal lesions were healed up, except in two cases, which were discharged against the physician's advice. The unimproved one showed no sign of improvement and the infection of the eye continued to extend deeper, terminating in panophthalmitis. This case was eviscerated.

The usual result of infected injuries to the cornea is panophthalmitis. From 1911 to the end of 1919, 174 cases were eviscerated and 149 enucleated, or a total of 323 eyes which were removed from the orbit in the Eye, Ear, Nose, and Throat

Department of the Philippine General Hospital. The large number of enucleations and eviscerations led us to work out a more conservative treatment, and to practice various methods of saving the eyes, the most important of which is corneal paracentesis. It must be admitted that but very little has been done on this operation lately, leaving a wide gap in the medical literature.

## CONCLUSIONS

In conclusion I should like to present to you the following facts for your consideration:

1. The treatment by corneal paracentesis of corneal ulcers, with hypopyon and disintegration of corneal tissues amounting to panophthalmitis, is very satisfactory, producing definite cure with complete recovery of vision and improvement in general of what may be considered as totally lost eyes.

2. This operation produces immediate relief of pains and tenderness of the eyeball caused by the intraocular tension due to the presence of pus and disintegrated tissues filling up the anterior chamber.

3. The evacuation of the pus from the anterior chamber not only gives immediate relief of the symptoms, but also prevents the extension of the infection into the deeper and vital structures of the eyeball which will result in serious complications of the injured eye and may even produce sympathetic ophthalmia of the good eye.

4. This operation gives a great opportunity for the diseased eye to recuperate, so that in those cases where recovery is not complete secondary operations such as iridectomy for artificial pupil may be possible.

5. The operation minimizes the extraction of the eyes by either enucleation or evisceration, keeping the eyeball intact, and in the majority of the cases tattooing of the cornea and plastic operations for the use of artificial eyes may be indicated.

6. The operation is simple and not dangerous, and in the hands of those who are experienced it is one of the safe operations in ocular surgery. It does not require complicated and expensive instruments.

7. Medicinal treatment, except the use of atropin, is practically of no value; this is very important in preventing serious complications largely affecting the vision, such as plastic iritis, seclusio et oclusio pupillae.

8. The technic used in this operation is an original one and different from those recommended by Saemisch, Guthrie, Schwenk, Meyrhofer, Wolfe, Wardrop, and others, in that the incision is made on the lower half of the corneal limbus on the healthy portion of the cornea without splitting the ulcer. The irrigation of the anterior chamber is not recommended by many authors.

Before concluding I should like to avail myself of this occasion to express my gratitude to Professor Ubaldo, chief of the department, for extending to me the opportunity to perform these operations and to carry out my observations on and post-operative treatment of all these cases.

# A CASE OF POLLAKIURIA IMMEDIATELY RELIEVED BY EXTERNAL LIBERATION OF THE PELVIC AND ILIAC PORTIONS OF THE URETER

By Dr. José Eduque

SIX PLATES

The case I am reporting this morning is that of a Filipina woman, 27 years old, housewife, a native of San Pablo, Laguna Province, and now residing at No. 114 Calle Loreto, Sampaloc District, who came to the hospital complaining of frequent troublesome urination and of a dull pain in the lumbar region, especially at the left loin.

*Past history.*—Measles and chickenpox when a child.

*Marital and obstetrical histories.*—Married in 1909. Had three successive abortions in 1910, 1911, and 1912, and was operated for hysteropexy in 1912 on account of improper position of the uterus. After the operation she was normally delivered of a full-term baby which is now living and well.

*Present illness.*—The present trouble may be said to date back to one year ago, when the patient had frequent attacks of pain in the back, of a dull and intermittent character, especially felt in the left side, and which radiated in several directions, sometimes upward, at other times to the anterior part of the chest, occasionally downward to the sacral region, and many times she felt it going toward the abdomen and bladder regions. She never recollected that these pains were so severe as necessarily to keep her in bed. The pain was never accompanied by nausea or vomiting, although there was frequent anorexia. The patient states that from the time of onset of the ailment up to the time of her admission to the Philippine General Hospital, she had noticed a slow but steady loss in weight. She also noticed irregular rise of temperature and frequent need of urinating, the urine in every instance being scanty and, though micturition was not particularly painful, she felt uneasy and obliged to empty her bladder despite the fact that she voided no more than two to three tablespoonfuls of urine at one time. This desire for frequent micturition was especially troublesome at night when at rest, and frequently kept her awake or disturbed her sleep. When this happened several successive nights, she felt particularly uncomfortable the day following from loss of sleep; she also lost appetite. According to the patient, when she was still at home there were nights when she lost practically all of her sleep, having to get up from fifteen to twenty times to void only a few cubic centimeters of urine. This happened especially when she had been engaged in somewhat heavy labor during the day or else when she had undergone some strain.

The urine had no definite character; sometimes it was abundant, and at others scanty. Its color on many occasions was somewhat whitish, not amberin, pale and simply cloudy, and at other times, it was lighter, less cloudy, or less opaque. Realizing that her condition grew from bad to worse, she decided to enter the hospital.

Her physical examination revealed: Chest normal in shape, fairly well developed but expanding rather poorly; voice sounds and tactile fremitus apparently normal; left pulmonary apex showed slight impairment in resonance, but no rales of whatever kind could be heard in any region of the lungs. Heart examination was negative.

The abdomen, aside from slight tenderness in the left hypochondrium elicited only on deep pressure, was practically normal. Extremities, negative.

Loin examination: The left lumbar region upon percussion was somewhat tender. By combined palpation, one was able to feel the lower pole of the left kidney, which did not wander even by changing the position from supine to sitting or even standing posture. The right loin showed some second-degree nephroptosis, but without inconvenience to the patient.

*Cystoscopic finding.*—The whole mucosa of the bladder was pale and covered by a thin layer of mucus. There were trabeculæ in certain areas at the bottom. Blood vessels scarcely visible. The trigonum vesicæ was a little darker than the rest of the bladder mucosa. The left ureteral meatus was hardly found on account of a rather thick sheet of mucus and pus covering the opening, which was situated in a slightly elevated area in that region. The meatus of the right ureter, on the contrary, was relatively free of such mucus and pus covering and was immediately found.

In view of this finding, my impression was that in the upper part of the left meatus uretericus there was some pathological condition which was not present in the right side. I, therefore, passed the ureteral catheter through the opening of the left ureter, injected a solution of collargol through the catheter, and had the patient X-rayed. See Plates 5 and 6.

The skiagraph shows that the solution of collargol was found only at the upper third of the ureter, the middle and lower thirds being completely devoid of any of the solution. To my mind, this absence of the solution of collargol from the lower parts meant that the site of pathological stenosis was along the whole extent of the middle and lower ureter, diminishing its lumen, and by periuretheral adhesions binding these portions of the ureter toward the middle line of the body, thus deviating these parts of the ureter from their normal situation and course. With this diagnosis in mind, the operation was advised, which was willingly acceded to by the patient so long as, in her words, she would be no longer bothered by michthiuria.

The technic of the operation was as follows: A left lateral incision across the abdomen was made beginning from a point 2 to 3 centimeters below the lowermost part of the left costal arch and corresponding to the external border of the left rectus abdominis muscle, downward toward the anterosuperior iliac spine to a point about 2 to 3 finger-breadths from it, and then curving inward and slightly downward toward the median line of the abdomen and distant about 3 to 4 finger-breadths from the iliac spine. The incision was deepened, cutting through the oblique muscles. A hæmorrhage, produced by severing the epigastric vessels, was controlled by clamp and ligature; then the fascia transversalis was carefully cut and separated from the parietal peritoneum, to avoid opening or injuring the peritoneal serosa. The peritoneum of the posterior abdominal wall was carefully rolled in with the fingers toward the median line of the abdomen, starting from the external iliac fossa, and when the external iliac artery was exposed this vessel was used as a guide in looking for the bifurcation of the primitive iliac at which level, on account of its hard feeling, the ureter previously catheterized was easily found. A portion of the ureter was localized in this way, and was traced upward and downward to appraise its course, and it was found to be surrounded by adhesions binding it toward the central side of the body. After carefully loosening up these adhesions along the extent of the middle and lower thirds of the ureter, I was finally able to lift up these portions of the duct and to bring them up through the wound. When the loosening up of the adhesions was completed and the ureter permitted to remain in its normal position, after removing the catheter, the closure of the wound was accomplished layer after layer; a cigarette drainage was inserted in the lower portion of the wound. A few days after the operation, it was noted that the patient was no longer troubled either by michthiuria or pollakiuria, and the average urination was only five or six times in twenty-four hours, which is about normal.

## BIBLIOGRAPHY

ALBARRAN, J. Medecin operative des voies urinaires (1909) 384–388.

BEER, A.; BRAUN, H.; and KÜMMEL, H. Chirurgische Operationslehre 3 (1913) 173–178.

SEGUEN, F. Traité chirurgical d'Urologie (1910) 555–557.

# ILLUSTRATIONS

[Plates 1 to 4 are drawn from photographs taken at different stages of the operation. All plates are arranged head up. The following letters have the same meaning on Plates 1 to 4: *a*, ureter; *b*, gauze impeding the ureter; *c*, retractor; *d*, muscles; *d'* muscles retracted; *e*, cavity left after rolling in of the peritoneum from the parietal wall of the abdomen; *f*, cigarette drainage inserted before completely closing the wound.]

### Plates 1 to 4

Operation for the external liberation of the pelvic and iliac portions of the ureter.

### Plate 5

Showing the condition of the upper third of the ureter after collargol injection.

### Plate 6

Showing the upper third of the ureter containing the collargol solution and the middle and lower thirds of the ureter completely devoid of the solution.

# INFORMAL PRESENTATION OF TWO UROLOGICAL CASES: ONE A DIVERTICULUM OF THE BLADDER, AND ONE A LEFT RENAL CALCULUS COMPLICATED BY PYELITIS

By Capt. Ivy A. Pelzman

*Medical Corps, United States Army*

### DIVERTICULUM OF THE BLADDER

James A. Sommerville, civilian employee, Quartermaster Corps, age 58.

Previous personal history: Negative, except for usual diseases of childhood.

Venereal history: Negative.

*History of present condition.*—The patient was first admitted to the Department Hospital on April 22, 1918. At that time his chief complaint was frequency of urination, burning pain on urination, and a bearing-down pain over the bladder region. He voided two or three times an hour during the day, and would have to get up as often as ten to twelve times during the night. He was placed on bladder irrigations and given urotropin internally, and after nine days in the hospital was discharged as slightly improved.

One month later he was readmitted complaining of a recurrence of the symptoms; he was in the hospital two weeks this time, and was again put on bladder irrigations and urotropin, and again discharged as improved.

Two days after discharge from the hospital he returned for his third admission with another recurrence of the acute urinary symptoms.

The diagnosis made during these various admissions was hypertrophied prostate and cystitis, acute, cause undetermined. Laboratory findings: Wassermann, negative; examination of prostatic secretion and sediment from urine, negative for gonococci; urinalysis showed marked reaction for albumin; microscopically, many pus cells; otherwise negative; stool and blood examinations, negative.

During these admissions he was not cystoscoped, nor was he X-rayed.

On July 24, 1918, the patient was transferred to Letterman General Hospital for four months; diagnosis of hypertrophied prostate and fungus growth of the bladder was made (this without a cystoscopy). An operation was advised, but it being explained to the patient that the operation was a very serious one he refused operation and returned to Manila, in February, 1919.

During his stay at the Letterman General Hospital he had daily bladder irrigations and was on urotropin internally. On admission his weight was 106 pounds and at the end of his four months' stay under good diet, rest, and daily bladder irrigations his weight increased to 140 pounds.

In August, 1919, the patient first came under my care with the past history as just given. Rectal examination showed a markedly enlarged prostate.

On cystoscopy an acute cystitis was found, the inflammation involving the entire bladder wall. The cystitis was so marked that it required four or five bladder washings before a clear field could be obtained. The ureteral orifices were easily located and were found to be normal. Slightly external to and about 2 centimeters above the left ureteral orifice was found the opening of a diverticulum. A ureteral catheter (X-ray) was passed into this opening and it was found that the catheter curved up within the diverticulum. The opening into the diverticulum was about 1 centimer in diameter. An X-ray picture was taken and with the catheter still within the diverticulum 10 per cent collargol was injected into the diverticulum and another X-ray was made.

At the first cystoscopy the maximum bladder capacity was 50 cubic centimeters of bladder fluid, and it was with great difficulty that a satisfactory cystoscopic examination was made. The residual urine amounted to 60 cubic centimeters. This urine was very turbid and had an extremely foul odor.

The patient has been on daily bladder irrigations of boric acid and silver nitrate, the latter in increasing strength. He has shown marked improvement in both general and local condition. His present weight is 140 pounds; his appetite is good; his bladder capacity at present is 140 cubic centimeters, as compared to 50 cubic centimeters when treatment was first started. Cystoscopically his bladder has shown marked improvement. The cystitis has practically entirely disappeared; the diverticulum, however, is still present. Where previously he would void two or three times an hour, he now can go from one hour to one and a half hours without voiding; at night he gets up to void two or three times instead of ten or twelve times. The patient has shown marked improvement, but of course will not be permanently cured unless prostatectomy and dissection of the diverticular sac be done. To date he has refused operation.

Diverticulum of the bladder is more prevalent than was formerly supposed, the present more frequent discovery of the condition being due to the fact that an absolute diagnosis is impossible without the aid of the cystoscope or the X-ray, although occasionally a fairly accurate diagnosis may be made by exclusion.

The etiology of bladder diverticulum is still sub judice. Some contend that this condition is always acquired, basing the contention principally on the presence or absence of muscular fibers in the sac. The probability is that a certain percentage of the cases is congenital; or rather, there probably is a congenital defect in the bladder wall which, under given conditions, acts as a predisposing cause to the development of the diverticulum.

The majority of urologists believe that diverticula are acquired. They base this contention on the fact that diverticula are scarcely ever found in the very young, but that, for the most part, they occur in persons past middle life, at which time obstructions to the urinary outlet most frequently occur.

As yet no experimental data have been offered to prove any theory thus far advanced; and, until some unassailable proof can be furnished, the exact etiology of diverticula will remain unsolved.

*Symptoms.*—Frequent urination with inability to empty the bladder completely is one of the commonest signs of the presence of a diverticulum. In most cases this does not cause any special annoyance until infection and cystitis develop, when the patient seeks advice because of the pain accompanying these conditions. Occasionally there is a burning or stinging sensation during and after micturition. If the diverticulum be infected, and in most cases it is, the urine even after repeated irrigations is cloudy and, in a great many cases, very fetid.

*Diagnosis.*—The presence of diverticula can nearly always be determined by the cystoscope in the hands of a person experienced in its use, but may be easily overlooked by the inexperienced. A diverticulum opening is sometimes so very small that it looks like a dark speck in the field. This apparently insignificant speck, however, may be the opening into a very large sac. The cystoscopic examination may be verified and the size and exact location of the diverticulum determined by the injection of collargol or other silver preparation, followed by an X-ray of the bladder region.

### A CASE OF LEFT RENAL CALCULUS COMPLICATED BY PYELITIS CAUSED BY BACILLUS PYOCYANEUS

*Case.*—H. G. E., wagon master, age 42.

*Personal history.*—For the past three years has had pains in left kidney region. These attacks occurred on an average of once a month and would last from a half hour to twenty-four hours. Attacks were severe and would radiate down to left groin; urination and hematuria frequent during an attack.

During the past ten months has been observing urine at intervals of two weeks. After an attack of pain would pass, he would notice eight or ten small calculi; the urine would be dark-colored at this time.

*Past history.*—Two weeks before admission had chills and fever, and slight pain in left renal region. Complains of loss of appetite, nausea, and vomiting. No frequency of urination, no burning pain. Urine was dark-colored and very turbid.

Cystoscopy showed mild degree of cystitis involving the entire bladder wall, the ureteral orifices apparently normal. Ureteral catheters, passed to both kidney levels, met no obstructions. X-ray of genitourinary tract, with X-ray catheters in situ, was negative for calculi. Examination of urine from left kidney showed many pus cells and the presence of *Bacillus pyocyaneus*. Repeated examinations verified these findings and showed that the finding of *Bacillus pyocyaneus* was not due to contamination. An autogenous vaccine was made from the pus obtained from the left kidney, and eight injections of this vaccine were given at intervals of four days; previous to the giving of the autogenous vaccine the patient ran a very septic course, the temperature varying from 97° F. to 105° F. The autogenous vaccine was given after this septic temperature had continued for three weeks. On the day of administering the first injection the temperature was 103.2° F.; with each succeeding injection of the vaccine the temperature declined toward normal until the end of the eighth injection, when the temperature reached normal and continued at normal.

This case is of interest, first, because of the cure by the administration of the vaccine; secondly, because of the organism causing the pyelitis. This is the fifth case of a series found in the past six months at the Department Hospital, in which *Bacillus pyocyaneus* was the causative agent of infection in the genitourinary tract.

# STREPTOCOCCUS HEMOLYTICUS: A CASE STUDY

By First Lieut. HARRY G. JOHNSON

*Medical Corps, United States Army*

The following case is reported in order to record a few of the manifestations of the streptococcus hemolyticus. I am submitting this for your approval or disapproval, at the suggestion of my senior officers. I hope it will carry a little of interest. It has no claim whatsoever to any scientific value.

The case is that of a man about 30 years of age, a Serbian by birth, and said to have been at one time an officer in the Medical Corps of the Serbian army. He had been under the care of the psychiatric service for some time as a case of dementia praecox, having the usual manifestations of negativism, necessitating at times tube feeding.

At the time this case entered the medical wards, we had been having an epidemic of diphtheria and streptococcic sore throat; so it was the rule to have a morning and afternoon routine examination of the throats of all psychiatric patients. This case was discovered to have a suspicious throat and had been immediately transferred to the medical service. The family and past history have no bearing on the case from the standpoint under consideration.

The physical examination at the time of admittance revealed a poorly nourished man, uncoöperative, and in a semiconscious state. The temperature, as recorded, was 102°; pulse, 90; respirations, 20. Head, negative; pupils, equal and reacting; chest, clear; and abdomen, negative. The genitourinary tract was apparently normal. Rectum revealed no hemorrhoids or other disease. The reflexes were present but sluggish. The patient had no skin abrasions. Examination of the mouth and nasopharynx showed the teeth to be in poor condition, the pharyngeal wall hyperæmic and œdematous, the uvula injected and both tonsils swollen. The tonsils and a small part of the posterior pillar of the right tonsil were covered with a thin, translucent, grayish membrane, which wiped off readily and did not bleed.

As mentioned before, the hospital had been having an epidemic of diphtheria, which at this time was being replaced by sore throat of streptococcus origin. Many of the diphtheria cases, as proven by bacteriological findings, were of a very atypical character, and many cases proven not to be diphtheria had many of the local manifestations of the disease. It may be said here that, in not a few diphtheria cases, no membrane was present, the throat showing only marked œdema and congestion. We soon found that a very reliable early sign in diphtheria was œdema of the uvula. Some cases resembled a mild follicular tonsillitis, but in these cases the cervical adenitis was usually prominent. On the other hand the streptococcus throat often resembled that of diphtheria, frequently a thin membrane being present over the tonsils; but very rarely did we find the membrane extending to the pillars, as was the case in diphtheria.

In the case under consideration, the local process manifesting itself as described in the throat, and being guided by the apparent toxemic condition of the patient, 22,000 units of diphtheria antitoxin were administered, after first endeavoring to desensitize the patient. The following day the report on the throat culture was returned from the laboratory. It showed streptococcus in nearly pure culture, which was later demonstrated to be a strain of the streptococcus hemolyticus. Blood count showed erythrocytes, 4,500,000; white count, 14,000; polymorphonuclears, 75 per cent; hemoglobin, 82 per cent. The temperature was not unusual.

On the afternoon of this day, the patient had a severe chill which was followed by a condition of clonic convulsions, lasting about an hour. Blood culture was taken, and spinal puncture performed. The spinal fluid was clear and showed a normal cell count and negative globulin. The local manifestations in the throat were somewhat improved, and continued to improve throughout the disease. No ulceration or deep-seated involvement occurred.

The next day the condition of the patient was very much worse. Toxic symptoms were pronounced. The temperature reached 104° and showed marked remissions. The leucocyte count was 17,000. The blood culture was reported to have a growth. This growth was later proven to be streptococcus, and in such quantity as to fill nearly one-quarter of the flask.

The case now resolving itself into a bacteræmia and septicæmia, the usual treament of elimination, and alkaline and glucose per rectum were started. In addition, Parke Davis polyvalent anti-streptococcus serum was given in 100 cubic centimeter doses every four hours, both intravenously and subcutaneously. About this time the patient was again searched for a possible focus other than in the throat, but none was found. The genitourinary tract and rectum were very closely studied, but found apparently free from disease.

The administration of the serum was continued at four-hour intervals for some days, and persisted in at longer intervals throughout the disease.

Blood cultures were taken every other day, and the second culture showed a diminution in the amount of growth. The leucocyte count on the fifth day was 22,000, with polymorphonuclear cells, 82 per cent. Here was recorded the first metastatic involvement. The metatarsophalangeal joint of the great toe of the right foot became very red and swollen, and on the following day presented signs of pus. The joint was opened and a small quantity of seropurulent fluid obtained. This was sent for culture.

The same day the left knee became involved, and this went on rapidly to suppuration. The joint was opened and the pus evacuated. This also was sent for culture. Other joints followed in rapid succession. Nearly overnight, a previously well joint would give signs of pus and have to be opened. The right knee, left ankle, left elbow, left knee, right wrist, right elbow, and right sacroiliac joints were all involved, and were opened and the pus cultured. A pure culture of streptococcus was obtained from the exudate from all the diseased joints. At first the exudate was of a thin seropurulent material, but this soon changed to a thick bloody pus.

All the incised joints were irrigated with Dakin's solution. Involvements followed each other so rapidly that after the eleventh day no new involvements occurred. The joints all continued to drain pus, and in those first affected distinct crepitation was obtained. On the twelfth day, the right parotid gland became involved and progressed rapidly to a suppurative parotiditis, draining spontaneously through the external ear.

During this time the blood cultures showed less and less growth until only a faint growth was obtained. Each culture showed the same organism. The temperature dropped and hovered around 102°. The general condition of the patient was apparently improved, and he was voluntarily taking nourishment. His mental condition had markedly changed, he now being seemingly rational and coöperative.

The blood cultures showing a diminishing growth, and with the apparent improvement in the general condition of the patient with no new involvements recently having occurred, it was thought that the infection had pretty well localized itself; so it was deemed advisable to stimulate antibody production by the administration of an autogenous vaccine. This vaccine was duly prepared and an initial dose of 2,000,000 given, and a second dose of 4,000,000. The serum was continued as before. About eight hours after the last dose of vaccine, the temperature suddenly rose to 104°, the pulse became very rapid, and the patient was in extreme condition.

The following morning, signs of fluid were demonstrated in the right chest and proven by aspiration. The fluid showed streptococcus. The next day, pus was obtained from the left chest. This also showed streptococcus.

Upon examining the patient the next morning, about the seventeenth day of the disease, a large swelling was noted over the anterior aspect of the left chest, extending from the upper border of the seventh rib to the nipple, and laterally from the edge of the sternum to 2 centimeters inside the anterior axillary line. This mass was about the size of a small grapefruit, and in it a distinct fluctuation was obtained.

An impulse was also distinctly evident in the mass, synchronous with each heartbeat and was transmitted all through the mass. The area of cardiac dullness, and the dullness in the mass, and the fluid in the right and left chests, all merged together. The heart sounds were barely audible. A diagnosis of a large pericardial effusion was made. A needle was inserted through the skin over the mass and pus obtained. The surgeon, from this evidence, considered the condition to be that of a large superficial abscess and advised incision, which was performed in the sixth interspace about the nipple line. Approximately 200 cubic centimeters of pus were obtained. The abscess evacuated itself in spurts, and each spurt apparently corresponded to each heartbeat. The incision was enlarged and the cavity explored, with the result that an irregular hole, about the size of a fifty-cent piece, was discovered through the intercostal muscles in the fifth interspace about the location of the costochondral junction of the fifth rib, which was necrotic.

The opening led directly into the pericardial cavity, and by inserting the finger into the same, the apex of the heart was felt distinctly under the finger. Reflex light thrown into the aperture revealed the apex of the heart to full view. A similar opening existed in the interspace. The parietal layers of the pleura and pericardium were adherent to themselves and adherent to the chest wall. A sinus existed between the pericardial cavity and the outside of the chest wall. A large purulent pericardial effusion, rapidly formed, had ruptured through the intercostal muscles spontaneously and had caused necrosis of the costochondral junction of the fifth left rib, and by means of the incision made through the skin an opening now existed from the exterior to the interior of the pericardial cavity. The patient lived three days in this condition. He died on the twentieth day.

Through some misunderstanding only a partial autopsy was performed, which demonstrated the pericardial sinus as described, and a condition of the joints in which the joint surfaces eroded until the bare bone ends lay in direct apposition. Pus was obtained from the peritoneal cavity and from the spinal canal.

This case was followed by another, with the primary infection in the lungs, which was demonstrated to be streptococcus hemolyticus and went on to the same fatal termination, developing all the severe involvements with the exception of the pericardium and joints.

This particular type of streptococcus played a large and important part in the causation of post measles and influenza pneumonia, at the army cantonments during 1918. The infection is usually a local process, but in some cases it may be a primary septicæmia.

The pneumonitis caused by this organism, occurring either primarily, or secondary to some predisposing disease, is of a peculiar and characteristic type. It is particularly fatal and prone to complications, the most common of which is empyema. In general, it may be said that streptococcus hemolyticus produces a bronchopneumonia affecting primarily the framework of the lungs and bronchial walls. The name interstitial pneumonia has been suggested, and it describes the condition. It is more or less associated with a diffuse or patchy lobular pneumonia. The bacteria can be found scattered in the alveolar exudate. Areas of this kind may, and frequently do, become confluent, and resemble a lobar pneumonia.

As shown by Tongs, the tonsils, especially the hyperplastic ones, are a frequent breeding place for the hemolytic streptococcus; but a complete tonsillectomy appears to be followed in most cases by the absence of the streptococcus from the throat.

Of the complications, empyema is the most common; septicæmia is not uncommon; pericarditis, multiple arthritis, and multiple abscesses may occur. Meningeal involvement was demonstrated in both cases recorded.

Hamilton and Havens have reported work which they have done with this organism and which gives promise. They claim to have studied many strains, which could be grouped in a few definite types. They report that they have found at least four groups, which were fairly distinct. These authors say:

> These groups are obtained by the serological reactions of the different strains, since the cultural characteristics have no relation to their immunological groupings. The serum of rabbits immunized with a strain of hemolyticus, protects mice against infection with a homologous strain, but not against strains which are serologically different. But certain "Master" strains can be isolated, by their serological reactions.

The suggestion is made that these strains may be used in the production of a serum for therapeutic use.

Certain differences between the hemolytic and nonhemolytic strains have been noticed. There is a tendency for the hemolytic strains to preserve the classical arrangements in chains made up of distinct cocci, and not to appear as chains made up of diplococci. The power actively to invade the body, exhibited by the hemolytic strains, which frequently produces epidemics, is not shared by the nonhemolytic strains.

## CONCLUSIONS DRAWN FROM OUR CASES

1. That the local manifestations in the throat were due to the streptococcus hemolyticus.

2. That there existed a true bacteræmia, septicæmia, and pyæmia, with primary focus probably in the throat.

3. That the streptococcus was isolated in pure culture from the exudates.

4. That there was apparent predilection of the streptococcus for all serous membranes and the extremely rapid development of pus.

5. That the serum at times appeared to have some beneficial results, but by laboratory experimentation with the serum against the culture from the patient, it was proven to have no serologic reaction.

6. That the autogenous vaccine was absolutely contra-indicated, and was only "adding insult to injury."

# CLINICAL STUDIES ON ENCEPHALITIS LETHARGICA

By Drs. P. LANTIN and W. VITUG

An unfamiliar malady was observed in the clinics of the Philippine General Hospital in the latter part of 1919. This unusual disease we refer to was the so-called encephalitis lethargica.

In reviewing the available statistics about outbreaks of this disease we found that, as early as 1712, encephalitis lethargica was observed by Camerarius in Tubingen; later it was reported in 1890 in Austria-Hungary and in northern Italy, where it received the name of encephalitis lethargica nona; lastly, in 1917, it was reported in Vienna by Von Economo. Since this last report, the scientific journals coming from Europe and the United States have brought numerous accounts concerning the disease.

Our observations on this disease have been very limited, and are based on only eight cases. The cases were all Filipinos, adults, consisting of two females and six males. Three cases were admitted in September, and five in October, 1919.

*Symptomatology.*—Encephalitis lethargica has many varieties of onset; the prodromal symptoms, however, in our cases point to involvement of the central nervous system. Some observers state that in many cases the disease starts with malaise and catarrh, involving the nose and pharynx, accompanied by slight cough. Some of our cases gave similar history. Our first case started with pain in the eyes, and severe headache, first localized in the frontal region, spreading afterwards all over the head. The second case began with pain in the shoulder. The third case began with choreic movements in the muscles of the face and extremities. The fourth case began with pain in the molar teeth, radiating to the head, accompanied by difficulty in swallowing, dyspnœa, palpitation, and restlessness. The remaining four cases began with heaviness in the head, gradually increasing, accompanied by headache, blurring of vision, vertigo, and general weakness. Fever and diplopia set in.

After from one to three days of fever and diplopia, stupor occurred. The patients slept most of the time, and could be awakened only with difficulty, answering questions intelligently, but slowly. Strabismus was usually present. Frequent involuntary twitching of the muscles of the face, neck, and extremities was observed. Supraorbital nerves were usually tender. Areas of hyperesthesia were elicited in many cases. The neck was not rigid, and Kernig's sign was absent; if present at all, it was usually very slight. In all the cases there was marked conjunctival injection. There was irregularity of the pupils, and they reacted slowly. The tongue was coated; the appetite, poor; bowel movements, constipated in most cases. Heart and lungs were apparently normal; liver and spleen, not palpable; knee reflexes, apparently normal. Slight leucocytosis with increase of polynuclears was present in the blood. Cerebrospinal fluid was clear and came out in drops; differential counts showed increased cellular contents; the highest count reached 77 per cubic millimeter, usually with predominance of polynuclears, rarely with small lymphocytes.

*Clinical course.*—The fever was remittent, sometimes intermittent, ranging from 37.5° C. to 38.5° C., rarely over 38.5° C. It lasted from four to twelve days and averaged six days. The patients gradually became stuporous, sleeping most of the time. In severe cases, deep coma set in with attacks of convulsions which continued until the patient died.

During the convalescent period we frequently observed transient rise of temperature, with the mind still unclear and speech slow. In all our cases there was accompanying general weakness and, at times, slight palpitation. Heaviness of the head persisted over a long period. In those who recovered no paralysis was observed.

Three important clinical symptoms are characteristic of encephalitis lethargica; namely, fever, diplopia, and stupor. They are regarded as the triad of symptoms of the disease, and when the triad is incomplete, the diagnosis is very difficult. In the majority of our cases, we observed symptoms of involvement of the third nerve, more than of any other cranial nerve. Pothier states that the fourth, sixth, seventh, ninth, tenth, and twelfth nerves were said to be affected. Marinesco, of Bucharest, states that the motor cranial nerve nuclei are involved, while the sensory nuclei escape.

*Mortality.*—Four out of our eight cases died, giving a mortality rate of 50 per cent. The French mortality rate is given as 50 per cent. Only three of our cases were autopsied, and the pathological findings showed characteristic lesions of the disease.

# XEROPHTHALMIA IN FOWLS FED ON POLISHED RICE AND ITS CLINICAL IMPORTANCE

By Drs. L. E. Guerrero and I. Concepcion

In 1909 Stepp for the first time deduced from his experimental work on rats that certain fatty substances, or some substances soluble in fats, were very essential to the maintenance of life and the growth of the organism. In 1913 McCollum and Davis, and Osborne and Mendel demonstrated that, in addition to proteins, carbohydrates, fats, and mineral salts, certain accessories, or complementary substances, were necessary for the proper nourishment and growth of the body. These accessories are two in number, and McCollum and Kenedy named them provisionally "fat soluble A" and "water soluble B".

Fat soluble A exists widely in animal and plant tissues. It has been found in butter fat, egg fat, beef fat, cod liver oil, the testes of codfish, the kidneys, liver and liver oil of pigs, in oleomargarine, fish fats, fish oils, dried unsweetened condensed milk, corn, wheat, rye, oats, plant leaves, cotton flour, cottonseed oil, flax seeds and millet seeds, soy beans, peas, and bananas. It is absent or present only in insignificant amounts in lard, pig's heart, pancreas, thymus and adrenals, olive oil, almond oil, linseed oil, corn oil, and in the oils of sunflower, soy beans, wheat, cottonseed, nut margarine, vegetable margarine, white beans, barley, and potatoes. It can be isolated from the animal tissues with ether, chloroform, benzine, and acetone. However, in order to isolate it from plants it is necessary to treat the mother substances with these solvents, and then extract it from the residue with hot alcohol.

McCollum and his coworkers have shown, by numerous experiments on rats fed on different mixtures of various purified food products, that the absence, or insufficiency, of fat soluble A from the food caused in these animals marked general malnutrition and œdema of the eyes which, on prolonged feeding, terminated in complete blindness and in the death of the animals. They have often averted and overcome xerophthalmia by placing the animals on any of the above-mentioned foods rich in fat soluble A.

McCollum and Simmonds believe that there are only two diseases caused by deficiency, in the sense that Funk uses the term; namely, polyneuritis and a condition characterized principally by retarded growth, malnutrition, and xerophthalmia consisting of œdema of the eyelids, corneal opacity, and purulent secretion. They are due to inadequate quantities of water soluble B and fat soluble A, respectively. According to these authors scurvy, pellagra, and rickets are not due to lack of specific vitamines in the foods as formerly believed by Funk, but to an unbalanced diet.

In our work on the biologic assay of the different tikitiki extracts made in Manila, we have observed blindness associated with marked cachexia in the controls and the test fowls. All five controls, which were fed exclusively on polished rice, developed polyneuritis—one with blindness, but it lived for more than one hundred days.

Of the thirty fowls which received polished rice and 5 mils of tikitiki extract daily, five developed polyneuritis, and seven developed xerophthalmia and died. Xerophthalmia appeared in these animals from the seventh to the seventy-ninth day of the experiment.

From these experiments we may deduce:

1. That polished rice is lacking not only in water soluble B which prevents polyneuritis, but also in fat soluble A which presides over the processes of growth and prevents the occurrence of xerophthalmia.

2. That tikitiki extract contains the water soluble B, but does not contain the fat soluble A.

McCollum and Davis have shown, in their experiments on rats, that rice polishings, which contain most of the fat, do not contain the fat soluble A; or, if they do contain it, it is in such insignificant amounts as to be insufficient to promote growth in these animals.

In later experiments, we shall endeavor to determine whether fat-soluble A is present or not in unpolished rice, using fowls instead of rats as our experimental animals. We are under the impression that unpolished rice contains this growth-promoting factor, for otherwise we can conceive of no reasonable explanation of the fact that chickens confined in cages for prolonged periods of time and fed on nothing but unpolished rice could live and remain in apparently perfect condition. We suppose that this is also the explanation of the common practice in the Islands of fattening chickens by keeping them confined in very narrow cages that prevent all movements except those of the head and neck. Fowls so confined fatten quickly if fed liberally on unhulled rice or corn.

The discovery of fat soluble A is of practical importance, because it elucidates certain clinical manifestations which until now have remained unexplained, or have been attributed to other causes.

Mori, in 1904, published his observation on a disease found in Japan and known in that country by the name of *hikan,* characterized principally by diarrhea, bulimia, cachexia, marked dryness of the skin and hair, and xerophthalmia. The course of this malady is chronic; it is rarely fatal. Death is usually due to septicemia, following the cachexia or the eye complications.

Hikan is a disease of second infancy, generally occurring in the dry season, in children between the ages of 2 and 5 years, and rarely in breast-fed children or in adults.

During a period of about three and a half years, Mori was able to study 1,511 cases among 45,162 patients. He claims that hikan is not found among the fishermen, but usually among the poor who live chiefly on vegetable diet. He believes that this ailment is caused mainly by deficient absorption of fats, and that cod liver oil, chicken livers, eel fat, and the oil of sesame possess unusual curative properties which bring about rapid disappearance of the symptoms.

Very recently Bloch reported from Copenhagen forty cases of necrosis of the cornea with ulceration, in children fed with skimmed milk. Of these cases, only five presented xerosis; twenty-seven, keratomalacia of both eyes; and seven, keratomalacia of only one eye. The patients, all of them children varying in age from a few months to 1 year, showed evidence of atrophy and dystrophy; the tissues appeared soft and œdematous, the emaciation was sometimes masked by the œdema, and in a few cases only weakness and pallor were observed; but in all the cases, there were marked evidences of retarded growth, and the skin was dry and was covered with a furfuraceous desquamation. The little patients lay, quiet, in profound apathy. They objected when disturbed, but remained quiet if let alone. He attributes the cause of this syndrome to insufficient intake of fats.

The majority of his cases occurred during the war; twenty-eight came from rural districts, and only eleven were from the city. The serious cases from the rural districts were fed on centrifuged milk, and this class of cases has been progressively increasing during the subsequent year. These patients received the cheapest kind of milk, which naturally contained very little fat. His treatment consisted only in breast-feeding, cod liver oil, and local treatment of the eyes. For older children he prescribed milk mixtures in addition to the oil. He calls attention to the fact that the lesions of the eyes may often be masked by a conjunctivitis, and that it is very probable that many cases of blindness and leucoma in the adult had their origin in an overlooked xerosis during infancy. The whole trouble, according to this observer, can be readily overcome by simply changing the diet to breast-feeding, and giving cod liver oil, the latter with or without sweetened whole milk.

Czerny and Keller, and recently Bloch, observed similar cases in children fed exclusively on carbohydrates.

Morand believes that the cause of this trouble is not entirely due to fat deficiency, as claimed by Bloch. After examining the records of his service, he found that two hundred five infants with fat-dyspepsia had been kept on a fat-poor diet for over two months without developing symptoms that might indicate disturbances from fat deficiency. He attributes the cause of xerophthalmia not so much to fat deficiency as to the pasteurization of the milk used. He mentions five infants with fat dyspepsia, complicated with pyuria, otitis, and pyodermitis, that were kept on a fat-poor diet, and that developed xerosis of the conjunctiva and showed no sign of growth. Up to a few months previous to illness these children were receiving raw milk; but, owing to a change in the management of the dairy, they had to be fed with pasteurized milk, which is in reality a denatured food and deficient in vitamines.

In order to show that pasteurization of the milk was the real cause of these disturbances, Morand continued to give these children the same nourishment, plus 10 mils of fresh milk before each feeding. This small quantity of fresh milk caused rapid disappearance of the xerosis. He believes that the success obtained was due to the vitamines and not to the small amount of fats contained in the 10 mils of fresh milk.

Ronne, an ophthalmologist, has also observed cases of xerophthalmia in children fed on casein and little carbohydrates. According to him the serious symptoms as well as the xerophthalmia come on suddenly, a fact which in his opinion suggests that the lack of vitamines is the real cause of the disturbances, for excessive carbohydrate diet could hardly produce such a sudden and stormy onset of the disease. He further affirms that xerophthalmia, when allowed to run its natural course without treatment, always terminates fatally. However, he has never seen a rapidly fatal case of carbohydrate-dyspepsia without xerophthalmia. He believes that the immediate cause of death is the loss of the resistance of the patient, and that there are evidences to sustain the theory that both the carbohydrate-dyspepsia and the avitaminosis contribute to the fatal termination of these cases. According to him, xerophthalmia is often, but not always, of dietetic origin. It is also found in tuberculous patients where the xerophthalmia appears to be due not to defective diet but rather to the inability to assimilate the accessory elements found in the food. There seems to be individual power of assimilation, as there are children who apparently do very well on a diet that in others would bring about serious xerophthalmia.

Before closing, we wish to call the attention of medical practitioners, and especially pediatricians and ophthalmologists, to the possibility of meeting in their practice similar cases, especially among the children of the poor, who are weaned early and placed on a rich carbohydrate diet. We should look for these cases in Manila, where the use of skimmed milk in the treatment of gastrointestinal troubles is becoming generalized.

# THE DUNHAM FAN IN ROENTGENOGRAMS

By First Lieut. PAUL S. SEABOLD

*Medical Corps, United States Army*

Without doubt, the factor most necessary in making a roentgenological diagnosis of pulmonary tuberculosis is a thorough knowledge of the finer anatomy of the lung. According to the most recent work of Dunham, of Cincinnati, we find that tuberculosis, from both an etiological and a pathological standpoint, is more fully explained.

Taking up the bronchial tree and going immediately to its most distal divisions, the respiratory bronchi, we find connected with these are many small alveoli known as the alveolar ductules, which in turn are again connected with the irregular atria. Emptying into the atria are the alveolar saccules, on all parts of whose circumference are found the pulmonary alveoli. The last division of the bronchial tree, before breaking up into the parenchymatous tissue of the lung, is the alveolar ductule; we consider it and all the air passages connected with it to be the primary lobule of the lung, the combination of great numbers of these making up the secondary lobule of the lung, which in turn makes up the bulk of the lung.

The blood vessels to be considered are the pulmonary and the bronchial.

The bronchial artery gives off its branches to the bronchi, connective and lymphoid tissues, also supplying the lymphatic glands at the hilum. This artery extends to the pleura by way of the thick connective tissue, giving blood supply there to the walls of the lymphatics.

The pulmonary artery follows the bronchial tree to its finest divisions, finally dividing into as many branches as there are atria.

The bronchial veins are only found at the hilum where they empty into the vena azygos, while the pulmonary vein starts from the fine venules in the pleura and at the distal end of the alveolar ductules from the mesh of the pulmonary capillaries.

The lymphatics form as a thick mesh in the walls of the bronchi which communicate freely with those of the pulmonary artery. Those of the pulmonary veins communicate with those of the pleura. Valves are present in the deeper lymphatic system, which open toward the hilum, while those on the periphery drain toward the pleura. No lymphatics are found distal to the alveolar ductules.

The masses of lymphoid tissue in the lungs are important, for they are very often the starting point of tuberculosis. Nodes are found along the larger bronchi but not in the region of the respiratory bronchi or alveolar ductules; they are always found in the angle of dividing bronchi. Small masses of lymphoid tissue have been demonstrated in the walls of the veins, also in the angle at the junction of two veins; it has also been found in the pleura around the radicles of the pulmonary artery. It is without doubt true that the lymphoid tissue is the primary focus of infection in tuberculosis, the phagocytes having carried the bacilli to this region from the smaller air spaces.

Having a knowledge of the arrangement of the air spaces and knowing that the secondary lobules are separated from each other in well-defined areas, we can easily distinguish between the primary and the secondary lobules; you will readily see that this arrangement of pulmonary tissue under certain pathological conditions, more particularly tuberculosis, will occasion an increase of density on a roentgenogram which, if viewed from the proper angle, will be more or less triangular in shape. This is what is known as the "Dunham fan;" it will usually be found at the end of a trunk composed of a bronchiole, blood vessels, and lymphatic and connective tissue. The size of the fan is determined by the number of lobules involved. The type of pathology will also influence the character of the density for, should it be an advanced condition, we will have a diffuse density with fans showing here and there, many of them irregular in size and shape. Thus the characteristic marking of a plate of pulmonary tuberculosis consists of fan-shaped density with the apex toward the hilum, and the base toward the pleura, the apex being connected with the hilum by a heavy trunk. If we have two or more such areas of differing density, we will see the picture of tuberculosis, the greatest density indicating the oldest lesion. There may be great variation of density in the fan, varying from radiating lines (known as linear markings) to a heavy blotting-out effect. The most striking characteristic lies in the varying degree of change in the different trunk groups, for one trunk may be involved while the one next to it may be absolutely clear. It is very striking that in the early adult cases the lesions are usually limited to the trunks of the upper lobes and more particularly the first interspace trunk.

In studying the linear markings of a given trunk, if we find that they are cottony or faintly obscured as by a cloud effect, and if the fan appears to be wide open, active tuberculosis must be considered. Should the linear markings be sharply defined, dense, and show sharp studding beyond the trunk, with the fan partially closed, a healed lesion is to be suspected.

Caseous bronchopneumonia gives us a picture showing a definite, heavy, flocculent density, usually in the more dependent portions of the lungs, and rarely in the apices. The fan previously described may or may not be seen; if the lesion is small and near the pleura, it is usually walled off by a heavy septum with flocculent densities beyond the trunk. If the lesion is large, it is frequently impossible to make out the borders of the triangles. With a condition such as this there is usually an old lesion at the apex, and frequently a cavity is seen.

The picture of miliary tuberculosis is very striking. The lung areas are spotted with fine, cottony granules of increased density, which may be discrete or confluent. These densities vary from the faintest shadow effects to brilliant discrete areas produced by calcification. The calcified areas are distinguished from those of anthracosis by the fact that the latter are usually more stellate, sharper, and thicker in character.

From what has been said you will readily appreciate that the Dunham fan, as it is called, plays a very important rôle in the roentgenological diagnosis of pulmonary tuberculosis, more particularly by the stereoscopic method. Before this was used, many early cases were overlooked.

# THE DISEASE-CARRIER PROBLEM IN THE PHILIPPINE ISLANDS

By Dr. Concha Brillantes

## INTRODUCTION

From the viewpoint of the epidemiologist, a carrier is of more concern than a frank case of a disease. This should be quite obvious; for the latter, being easily recognized, even by the laity, usually comes under official notice either through the report of a physician, a neighbor, or a member of the family, or comes to the attention of a house-to-house inspector. On the other hand, carriers may be recognized by a laboratory examination only. This is a task of some difficulty and not a little uncertainty, because the taking of specimens is subject to opposition on the part of the public, who consider the act a violation of their personal rights; besides which, they fear the hospitalization or sanitary isolation consequent on a positive finding. Furthermore, the person may be a real carrier, but the laboratory may fail to detect the organisms because of error in the taking or transportation of the specimen, delayed examination, etc.

A carrier is a hidden focus of infection for other persons and a menace to himself—a focus which, unless discovered by the laboratory, the sanitarian cannot control. His detection and control therefore constitute one of the most important problems in the suppression of disease in which carriers play a part.

So far as I have been able to ascertain, carriers were first discovered in connection with cholera. For some time Koch held the view that man is the "real bearer and reproducer of the cholera organism." Many isolated epidemics could be explained only on the assumption that completely healthy persons, or those not noticeably diseased, had introduced the organisms. This assumption was first confirmed by W. P. Dunbar in the winter epidemic in Hamburg in 1892–93 when, by the use of the peptone culture medium, he found the cholera vibrio in the stools of no less than twenty-eight healthy persons, who had never had cholera nor the slightest diarrhœa.

The object of this paper is to collect and set forth certain salient facts concerning carriers in order that they may be available for quick reference.

## TYPHOID CARRIERS

The general belief that typhoid fever is not as common in the Tropics as in temperate climates has been found to hold true in the Philippines, according to the experience of the Bureau of Health. For several years (since 1900) it did not cause anxiety to the health officials because only sporadic cases occurred from time to time. Heiser in 1906–07, in view of Soper's investigations in New York and the occurrence of a preponderance of the cases among Americans and Japanese in the Philippines, announced the probability of the arrival of foreigners with infected gall bladders, or who at least would be discharging typhoid bacilli in their stools. During 1908–09 he warned against the possibility of the spread of typhoid through milk contaminated by infected water or by the hands of bacillus carriers, but added that this mode of spread may be disregarded since milk is not used on a large scale here.

During 1910–11 Fox emphasized the fact that it is the walking cases and the bacillus carriers that constitute the danger. Up to this time, however, laboratory confirmation was lacking.

In December, 1914, because of the increased prevalence of typhoid, a systematic examination of water, milk, and the fæces of persons working in dairies, restaurants, etc., was undertaken. As a result, thousands of fæcal examinations were made but, fortunately, none of them proved positive for the bacillus. Similar negative results were obtained with drinking water and with milk.

In 1915 the experience of the previous year was repeated. Of the 411 specimens from contacts (covering the entire year) none was positive. In the survey for intestinal infection, out of 6,201 specimens examined, only 4 were positive for the typhoid bacillus.

In 1916 the board, appointed to investigate the causes of the persistence of typhoid in Manila, after a thorough study of the subject, arrived at the following conclusions:

1. That the Centro Escolar outbreak very probably had its origin in a carrier (a servant).
2. That paratyphoid is more prevalent than typhoid in Manila.
3. That persistence is due to contact infection from either

cases or carriers, and more often cases than carriers since, in spite of the extensive examinations made to detect the latter, very few have been found.

Experience with one case in Bilibid Prison, in 1917, would appear to indicate that the patient had been a carrier for more than four months before coming down with the disease.

The Philippine Health Service stated, in 1917, that antityphoid vaccination will not rid carriers of the bacilli. In connection with carriers, the Service made the following statements.

1. A positive Widal may indicate that a person has suffered a previous severe or mild form of typhoid; that he has received antityphoid vaccination; or that he is a "carrier" (commonly believed to have suffered from an unrecognized attack).

2. A positive Widal cannot be pronounced a "carrier" unless actual discharge of bacilli, by fæces or urine, is shown.

3. A typhoid carrier is not a danger to himself, but is such to unaffected people; therefore he should be debarred from places where food and drink are dispensed. For urinary carriers urotropin should be administered.

So far no work has been done on treatment of intestinal carriers.

In a survey (1917) of cases and contacts the following results were obtained: In the group of cases, recognized or suspected clinically, 62.98 per cent gave a positive Widal test, while for the contacts the percentage was only 9.21. Of great importance is the fact that out of the twenty-five fæcal specimens from convalescents and other presumptive carriers, in only one was *Bacillus typhosus* demonstrated. One explanation offered for this encouragingly negative result was that possibly the vitality of the tropical strain of bacillus is shorter than has been observed in cold climates.

These findings therefore tend to show that there is hope of reducing the incidence of typhoid, and even of completely eradicating the disease.

### DIPHTHERIA CARRIERS

In 1900 sporadic cases of diphtheria began to be reported in Manila. From one case reported in 1900 there was a gradual increase to eight in 1906, the mortality having always been 100 per cent. From fifteen cases in 1907 there was an increase to forty-nine in 1912, the mortality having relatively decreased. Cases, few in number, began to be reported from the provinces.

It was during 1911 and 1912 that the first diphtheria carriers were detected, twenty-four having been found. Examination was done, as customary, by the laboratory of the Bureau of Science, for the Bureau of Health. As the health officials looked upon these carriers as being more dangerous in the spread of infection than the frank cases of diphtheria, the former were all isolated and so kept until the bacilli disappeared as shown by two successive negative findings on separate days. In consequence of this discovery, and in order to combat the disease, specific instructions were issued to medical officers, one important feature of which was that relating to the detection and control of carriers. Worthy of mention is the fact that the longest time that bacilli have remained in the throats of diphtheria patients in San Lazaro Hospital was twenty-eight days from the time of disappearance of the symptoms. The longest time for a contact carrier to harbor the bacilli after admittance to the hospital was eighteen days.

From that time on, carriers have been continually detected in connection with the annual outbreaks of diphtheria.

The 1915 outbreak was attended by a high mortality and the occurrence of a large number of carriers from whom a high proportion, 35.71 per cent, of virulent cultures was isolated by the Bureau of Science. One important thing observed in this outbreak was the development of symptoms of diphtheria (fever, pharyngitis, etc.) in twenty-two, or 3.65 per cent, of the carriers after admission to the hospital. Prompt administration of serum prevented the further development of the disease and probably the death of the patients. The Health Service strongly suspected that the sporadic but constant appearance of cases might possibly be due to perpetuation of a certain strain through the agency of bacillus carriers.

In 1915 a survey of diphtheria carriers among exposed persons in households, schools, and other institutions revealed the existence of 9.64 per cent of diphtheria carriers, which is excessive as compared with 3 per cent reported for some parts of the United States. This signifies: (1) perpetuation of a certain strain in Manila by uncontrolled carriers; or (2) an indication of an actual or closely threatening epidemic. The development of symptoms in some carriers was explained by the possibility of increase in virulence of harmless bacilli in carriers.

In 1916 the diphtheria outbreak showed a marked improvement from the epidemiological standpoint, because there was a marked reduction in:

Percentage of positives out of all cases reported.
Percentage of mortality of positive cases.
Percentage of positive carriers.
Virulence of local strains of diphtheria bacillus (cases and carriers).

These results are evidently due, if not entirely at least largely, to the antidiphtheria campaign undertaken in the previous year.

During 1917 and 1918 there was a continuous reduction in incidence of both cases and carriers, but the mortality rate increased. Although this comparatively high mortality is puzzling the Health Service, yet, so far, not enough research has been done to find an explanation for it.

## CHOLERA CARRIERS

For quite a long time the frequent reappearance of cholera in the Philippines has puzzled the health authorities; so much so, that on February 28, 1908, Heiser, then Director of Health, announced his hypothesis concerning this frequent reappearance; namely, that the cholera vibrio remains in the sewer system (the old Spanish sewers provided for storm water) and by contamination of water and food gets into the human intestine. He therefore advocated a thorough disinfection of these sewers. In view of recently acquired knowledge, this assumption may very well be disregarded. It was Marshall who, on the same date, first noticed the presence of cholera vibrios in stools of convalescents from cholera: in one case for four days and in another for ten days, when the patient left the hospital and was lost sight of. He emphasized the importance of this occurrence in its bearing upon the spread of the disease.

McLaughlin on October 19, 1908, however, was the first to draw attention to the existence of cholera-vibrio carriers. The discovery was made in connection with the outbreak in Bilibid Prison, when he ordered stool examinations to be made of persons who had to do with the preparation and handling of food and drink. Several healthy persons in this group gave positive findings for cholera vibrios; but upon compliance with his orders to wash and disinfect the hands (in a disinfecting solution), after stool and before eating, no more cases appeared in spite of the presence of carriers. Examination of apparently healthy persons in Meisic and Tondo shortly after showed 7 per cent of them to be bacillus carriers. He then stated that the existence of carriers, together with bad closet facilities and the failure to report cases early, were the factors that, more than any others, operated to make cholera suppression difficult. McLaughlin concluded from his experience in these outbreaks that the most important rôle in the transmission was played by the carriers. As a result of this important discovery, it has been suspected that possibly some carriers were introduced from near-by foreign countries, and since then the routine practice of examining the stools of all steerage passengers from cholera-infected districts was followed; at the same time the examination of the fæces of all suspects, and of all persons engaged in handling food for public consumption, became also a routine practice. All carriers were sent to San Lazaro Hospital, and there detained until the vibrios disappeared from their stools.

In July, 1911, seven contacts of a positive case proved to be carriers, but none of them developed cholera. All of these were retained till the vibrios disappeared, and no more cases developed. One carrier was discovered in a Chinese immigrant from Canton. Hence the possibility that some outbreaks were caused by carriers from abroad was considered.

In August, 1913, there was another outbreak of cholera, the first cases occurring in widely separated places with apparently no connection between them. All carriers found were isolated in cholera hospitals or other quarters, and the outbreak was suppressed.

In the same way the 1914 outbreak was suppressed by the isolation of cases and carriers. The disease seemed not to have been introduced from foreign countries, since no carriers were detected during the quarantine period. That year the cholera-carrier survey was more extensive, including the personnel of all establishments selling food, and remote contacts, such as persons living in the same block where a suspected case or a positive carrier was found. As a result it was found that out of 37,160 specimens, 530, or 1.42 per cent, were carriers. One important discovery took place in Bilibid Prison where out of 179 carriers, 5 developed the symptoms of cholera from four to eighteen days after having been found positive for the vibrios.

In 1914 carriers were also detected in the bodies of those dead of other diseases, such as enteritis, diarrhœa, dysentery, infantile beriberi, pulmonary tuberculosis, and intestinal tuberculosis. These findings led Munson to the belief that possibly any intestinal disorder materially predisposes to the development of cholera infection if the latter gains access to the alimentary tract.

Munson, in 1914, mentions the occurrence of a number of intermittent carriers in Bilibid Prison, one of them for over seven weeks. In the same institution an individual, after having been a case in 1913, was found to be a carrier in 1914. It therefore remained to determine the limit of the viability of the vibrio in the intestine. The possibility of these individuals having harbored the vibrios for the whole time (one of them over a year) and being representative of persons responsible for the annual outbreaks, was recognized. Treatment with salol was apparently of little value, since some carriers receiving it for some time developed the disease, and one of them even died.

In 1915 Schöbl reported the examination of thirty-nine gall bladders, seventeen of which were positive for vibrios while the intestines of the same cases were all positive. All of the forty-one specimens of urine from patients and convalescents were negative, while the fæces from the same were positive.

A little later the same author succeeded in producing carriers among guinea pigs by inoculation of living cultures of cholera vibrios into the gall bladder, stomach, small intestines, and serous cavity, and by feeding, although the duration of this state was limited to fourteen days. He also determined that in these experimental cholera carriers there was an infection of the gall bladder caused by the injected cholera vibrios, the latter therefore not only surviving there as mere saprophytes. He also found that infection may extend to the liver. Cholera vibrios were absent from the blood, lungs, and spleen; hence the improbable septicæmic character of the infection. The excretion of vibrios was irregular, so we see that this corresponds to the occurrence of intermittent human carriers.

Coulter in 1915, and Crowell and Johnston in 1917, also found gall-bladder infections in connection with cholera carriers, as well as the presence of cholera vibrios in the bile. As compared with the results of the cholera-carrier survey in 1914 there was observed in 1915 a marked decrease, the incidence being only 0.41 per cent (1.42 per cent in 1914).

Long, in 1916, stated that it has been demonstrated pretty conclusively that when a cholera carrier is given a severe purge, or when he (the carrier) ingests food or other substances which have the effect of producing a severe purge, the carrier frequently is converted into an actual case.

A suggestion of this developed in a recrudescence of the cholera outbreak of that year, which came in November and December. It developed, on investigation, that at this time

Manila Bay was invaded by swarms of a flagellated protozoön of the family Peridinidæ and that, as a result, large numbers of fish and crustacea were killed. These were gathered up by local fishermen, their capture being easy, and sold to the poorer people. Much of this food was already decomposing and as a result there was soon a rather extensive outbreak of intestinal disorder.

It was not definitely determined at this time whether the illness was of the nature of food poisoning or whether a proportion of the cases represented true cholera. Undoubtedly, many of these cases were cholera, and it might be assumed that these represented carriers in which the infective germs had been called into activity as a result of the gastrointestinal irritation produced by the ingestion of the partially decomposed sea food. In passing, it must be remarked, however, that the cholera epidemic was on the decline when this happened; secondly, a very small proportion of the cases were bacteriologically positive for the vibrio and, lastly, the mortality was far below that of the minimum mortality in cholera.

Johnston, from September, 1914, to December, 1917, noticed the occurrence of intermittent carriers as well as of nonagglutinable vibrios. These findings made it the more difficult to determine the duration of the carrier state.

Schöbl, in 1916, demonstrated that administration of bile to experimental cholera carriers prolonged the carrier state and caused a more frequent excretion of vibrios than in normal carriers. This evidently is a great help in the detection of normal carriers. He also found specific immune bodies in the blood serum of experimental carriers.

The same author, in 1917, found some chemicals which produced slight curative effects upon experimental vibrio carriers, among them being guaiacol, pyrogallol, atoxyl, sodium cacodylate, arsenic trioxide, and Ehrlich-Hata 606. These experiments are by no means final; still they yield some hope for the treatment of carriers. The phenol group and some of the arsenic compounds are of some promise. Combination treatment by several drugs also suggests itself.

In 1917 the Health Service paid more attention to the occurrence of nonagglutinable vibrios and after a study of the question came to these provisional conclusions:

1. That atypical cases with marked symptoms may coincide with the presence of nonagglutinable vibrios and the absence of the classic agglutinable ones.

2. That, in a number of cases and carriers, the preëxisting vibrios (either agglutinable or nonagglutinable) may change into the opposite and that, hence, it is unwise in any anticholera campaign to disregard the existence of nonagglutinable vibrios.

### BACILLARY DYSENTERY CARRIERS

In connection with bacillary dysentery carriers the literature is very scant. In 1914 the Bureau of Health stated that the Igorrots were frequently afflicted with, or had among them carriers of, bacillary dysentery. There is, however, nothing mentioned in connection with any definite examination to detect this condition.

### CONCLUSIONS

1. Carriers of typhoid, cholera, and diphtheria have been definitely proven to occur in the Philippines, but so far the greatest amount of research has been done in connection with cholera-vibrio carriers.

2. Carriers apparently do not play an appreciable part in the spread of typhoid fever, at least in Manila.

3. Carriers of the diphtheria and cholera bacilli, on the other hand, do play an important rôle in the dissemination of these diseases and constitute the main factors in the annual outbreaks that have been observed.

# AUTOINFECTION, SO-CALLED, DURING THE PUERPERIUM

By Dr. G. Rustia

Puerperal infection has been known as a morbid entity since the early history of medicine. It has been the subject of many investigations through all ages. Denmann (1788) was the first to observe that the disease was transmitted from cases of puerperal fever to healthy puerperal women by physicians and midwives. This view was strongly supported by Alexander Gordon, of Aberdeen, in 1795, and by Oliver Wendell Holmes, of America, in 1843. Gordon showed the infective nature of the disease, and Holmes showed the evidence that it was carried from patient to patient. The last named was confident that it could be conveyed in a similar way from a case of erysipelas, or from a postmortem, and that it was necessary for the physician to disinfect his hands and to change his clothes after attending a case of puerperal infection. This work was put upon a sound basis by Semmelweiss of the Lying-In Hospital of Vienna, who came to the conclusion from his brilliant researches that the introduction of "cadaveric poison" was the main cause of puerperal infection. The introduction by him of the use of chlorine water and solution of chloride of lime for cleansing the hands of the students and nurses attending labor cases reduced the mortality rate to 1.27 per cent in 1848. His theories were first ridiculed by his colleagues of that time, but were finally recognized when Pasteur discovered in 1878–79 the streptococcus in the uterine discharge, blood, and tissues (postmortem) of puerperal fever patients. They thus recognized external infection.

Leading obstetricians confirmed the finding of Pasteur, and it is a well-known fact to-day that the streptococcus in many instances is the sole cause of this disease. But years after the discovery of Pasteur, the streptococcus was found to harbor normally in the genital canal of healthy parturient women, as shown by Doderlein, Bumm, Walton and Medalia, and others.

The question now arises: Is this organism, found in healthy parturient women, the same that causes puerperal infection?

In other words, is so-called autoinfection during puerperium possible?

Kaltenbach, in 1888, admits the possibility of autoinfection in the following sentence of his communication to the German Gynecological Society:

> It is possible that pathogenic organisms may harbor in the genital tract during pregnancy without giving rise to any symptoms and only exert their influence during labor or the puerperium when the wounds following delivery will afford opportunity for their growth and absorption. Of course, in the strict sense of the words, this is not autoinfection, but merely a variety of external infection, the only difference from the usual form of contact infection being the length of time that the offending microorganisms have been in the genital tract. Thus, admitting that the vagina may contain pathogenic organisms, it is admissible that they may lead to infection without any further introduction of organisms from without.

The possibility of autoinfection, therefore, must stand or fall by the demonstration of pathogenic organisms within the genital tract of pregnant, parturient, or puerperal women who have not been examined previously.

The streptococcus group, because of their well-known importance in puerperal infection, have interested many in the study of vaginal bacteriology during the later weeks of pregnancy. Doderlein in his study of one hundred ninety-five cases distinguished two varieties of vaginal secretion; namely, normal and pathological. In the normal vaginal secretion he found a facultative anaërobic bacillus in frequent association with a type of blastomycetes which he believed to be *Saccharomyces albicans*. This bacillus which bears his name was found to be nonpathogenic. He accordingly concluded that the normal secretion presents no possibility for autoinfection, because of being bactericidal to pus-producing organisms. On the other hand, he found pathogenic streptococci in 10 per cent of the pathological vaginal secretions. This pathological secretion may afford then an opportunity for autoinfection, because of the possibility of the presence of a streptococcus which was pathogenic in more than half of his cases. Joeten, in 1912, reported one hundred antepartum cultures with streptococci in sixty-seven; fourteen of these were hemolytic, but evidence of the pathogenicity of these bacteria was wanting. Walton and Medalia (1912) found streptococci present in the vagina of pregnant women in from 10 to 40 per cent. They worked on the hemolytic and nonhemolytic form without, however, differentiating them further. In the one hundred three cases which they studied, antepartum and postpartum, the only two cases with morbid temperature out of the nine with hemolytic streptococcus postpartum had streptococci antepartum; one of these was found distinctly hemolytic antepartum while the other was not tested for hemolysis. Similarly, they found two out of four cases with morbid temperature due to nonhemolytic streptococci postpartum which had the same microörganisms antepartum. Permar (1916), writing on the bacterial flora in later pregnancy, apparently recognized puerperal infection carriers. He states:

> The presence in the vagina of streptococci giving the carbohydrate reaction of virulent organisms as well as those of less virulent character, but corresponding to forms recognized as having definitely invasive qualities is comparable to that recognized in the other cavities in which virulent or apparently virulent organisms are constantly present without giving rise to disease processes.

Bumm claimed to have found streptococcus in 50 per cent of normal, pregnant women, and that 75 per cent of healthy puerperal women were carriers of streptococcus. In his communication to the Tenth German Gynecological meeting, at Wurzburg in 1903, he says:

> The great problem is this: Are the streptococci which we find regularly in the majority of cases of all pregnant and parturient women identical with the streptococcus found in septic wound infection only existing in a temporarily avirulent stage; and have they nothing at all in common with the streptococci causing septic infection except only in outside similarity in form belonging altogether to another harmless type of organism? I believe that at this stage all the future bacteriologic researches will have to be applied towards the differentiation of the various types of streptococci found. That streptococci are present in the genitalia can not be doubted to-day. The question to be studied now is the relation of such to the quality of the streptococci derived from sepsis.

This problem laid down by Bumm has been the subject of many investigations.

Various classifications of streptococcus were made and several varieties of streptococci were observed in the numerous pathologic processes; but, while the bacteriologist has largely used the carbohydrate fermentation tests, the medical man has observed the hemolytic character, so that the results of these scientists cannot be compared. In recent years, the majority of authors who have used the blood agar plate method as a means of primary classification of streptococci into hemolytic and nonhemolytic strains have further extended the classification of streptococci already grouped on the basis of fermentation tests. In fact, the consensus to-day is that the most satisfactory classification of streptococci for practical purposes is that of Holman, which consists in a primary differentiation of hemolytic and nonhemolytic strains by the superficial streak method on blood agar plate followed by differentiation by the use of sugar media: lactose, mannite, and salicin.

To simplify our work we followed the last-mentioned classification. I will give now a preliminary report of the results of our investigation and will reserve the technical part of the work for a later publication when I hope to be able to report the results of investigations covering a greater number of cases than at present. We made bacteriological examination of the secretion from the cervix uteri and posterior cul-de-sac in every patient, before and after delivery. Doderlein's classification of vaginal secretion was not made. In a series of eighty cases examined, antepartum and postpartum, the results are as follows:

*Bacterial findings in the eighty cases examined anterpartum.*

| | Cases. |
|---|---|
| Hemolytic streptococcus | 15 |
| Nonhemolytic streptococcus | 3 |
| Bacteria other than streptococcus | 53 |
| Sterile | 9 |

*Results as to distribution of bacteria in the eighty cases examined antepartum.*

| | Cases. |
|---|---|
| Cervix: | |
| Hemolytic streptococcus | 12 |
| Nonhemolytic streptococcus | 3 |
| Bacteria other than streptococcus | 39 |
| Sterile | 26 |
| Vagina (posterior cul-de-sac): | |
| Hemolytic streptococcus | 15 |
| Nonhemolytic streptococcus | 3 |
| Bacteria other than streptococcus | 53 |
| Sterile | 9 |

*Bacterial findings in the same eighty cases postpartum.*

| | Cases. |
|---|---|
| Hemolytic streptococcus | 20 |
| Nonhemolytic streptococcus | 10 |
| Bacteria other than streptococcus | 47 |
| Sterile | 3 |

*Results as to distribution of bacteria in the same eighty cases postpartum.*

| | Cases. |
|---|---|
| Cervix: | |
| Hemolytic streptococcus | 13 |
| Nonhemolytic streptococcus | 9 |
| Bacteria other than streptococcus | 32 |
| Sterile | 26 |
| Vagina (posterior cul-de-sac): | |
| Hemolytic streptococcus | 20 |
| Nonhemolytic streptococcus | 10 |
| Bacteria other than streptococcus | 47 |
| Sterile | 3 |

Among the fifteen strains of hemolytic streptococcus found antepartum and differentiated further by means of carbohydrate fermentation, eleven were shown to be *Streptococcus pyogenes*, according to Holman's classification. Of these eleven, four had caused infection during the puerperium, two of which were recovered in pure culture, and the other two were associated with *Staphylococcus aureus*. Of the three nonhemolytic streptococci isolated antepartum, one was found to cause fever during the puerperium.

These facts seem to show beyond doubt that autoinfection plays an important rôle in the causation of puerperal infection, whether due to hemolytic or to nonhemolytic streptotococcus.

## CONCLUSIONS

1. Healthy pregnant, parturient, and puerperal women who have not been previously examined may normally harbor pathogenic streptococci in the genital canal.

2. The so-called autoinfection does really exist, but it should not be emphasized to such an extent as to impair the importance of aseptic and antiseptic procedures in handling obstetrical cases.

## REFERENCES

HOLMAN, W. L. The classification of streptococci. Journ. Med. Res. **34** (1916).

WALTON and MEDALIA. Hemolytic streptococcus and puerperal septicemia. Surg., Gynecol. and Obstetr. **15** (1912).

WILLIAMS, J. W. Puerperal infection considered from a bacteriological point of view, with special reference to the question of autoinfection. Am. Journ. Med. Sci. **106** (1893).

# PATHOLOGICAL FINDINGS IN THREE CASES OF ENCEPHALITIS LETHARGICA

By Dr. W. de Leon

Previous to the recognition of encephalitis lethargica as a distinct entity there were published in many European journals, chiefly British and French, reports of cases of a peculiar derangement of the central nervous system, mostly manifesting itself in queer mental torpidity, lethargy, at times unconsciousness, and irritation of cranial nerves.

Due to the similarity of symptoms, the British authors at first thought this mysterious disease to be identical with botulism. Other writers described the disease under basal leptomeningitis, toxic ophthalmoplegia, epidemic polioencephalitis, and encephalomyelitis, depending upon the site of the irritation in the nervous system. Those who have had opportunity to perform postmortem examination of cases dying of this affection could find no definite gross anatomical lesions to account for death.

About the latter part of 1919, and after the great epidemic of influenza which swept over these Islands, we used to meet cases at the autopsy table, from the Philippine General Hospital, with clinical evidence of nervous involvement, in which after examination we failed to find any corresponding gross anatomic lesions.

Such was the fact with a body that was transferred to the morgue with the clinical diagnosis of typhoid with signs of meningismus during life. At autopsy, all the organs were negative except for the presence of marked passive congestion of all the viscera, and some edema and injection of the mucosa of the intestines. There were absolutely no typhoid lesions in the gut. The brain, however, was not examined.

It was then suggested by Doctor Wade that a careful, thorough, and minute inspection of the brain be made of those cases that gave history of disturbance of the central or peripheral nervous system, especially when no gross anatomical manifestation to explain death was found. To him also belonged the privilege of examining at autopsy the first case of those that I am to report to-day.

This was a male of 47 years, who died after a 10-day stay in the hospital. The clinical diagnosis was meningitis and acute nephritis. Autopsy was performed sixteen hours after death. The body was well developed and poorly nourished.

The lungs were congested and showed areas of ecchymosis posteriorly, with here and there irregular patches of consolidation. The bronchi were congested and contained purulent exudate.

The brain showed nothing of interest except a marked injection of the larger and smaller vessels over the entire surface. The heart showed slight enlargement and some myocardial degeneration. There was slight chronic nephritis. The aorta was slightly atheromatous. The rest of the viscera showed marked congestion.

Anatomical diagnosis: Influenza; acute, purulent bronchitis; early bronchopneumonia; acute myocardial degeneration; dilatation of the heart; acute and chronic nephritis; congestion of the brain; moderate chronic splenitis; moderate arteriosclerosis. Cultures from the lungs were negative for influenza bacillus, and positive for a nonhemolizing streptococcus and for a diphtheroid.

Histologically, sections from the different places of the cerebral cortex passing through the internal capsules, the basal ganglia, and the peduncle showed marked engorgement of the cerebral capillaries. In a few there were found hyaline thrombi that contained polymorphonuclears. Hemorrhages into the perivascular spaces were met with and many of the vessels were markedly infiltrated at the periphery and in the adventitia with small mononuclear cells, one, two, or three layers deep. It is not very unusual to find a slight amount of serous exudate, or delicate fibrils of fibrin around the blood vessels among which are seen the layers of infiltrating round cells. It is common also to see a layer of these white cells laid along the intima of the vessels. Not only are the perivascular spaces infiltrated, but in places, especially in those portions of the cerebral ganglia where the vessels show prominent changes, the surrounding nervous tissue as well is slightly diffusely infiltrated with round cells; at least these tissues look peculiarly different in being more cellular than portions not so infiltrated.

In sections of the spinal cord the meningeal vessels appeared engorged and the meninges showed slight, diffuse, small, mononuclear infiltration. Both the anterior and the posterior cornua were affected, where most of the vessels are engorged and profusely infiltrated peripherally. In these regions the nerve cells did not appear to be normal; most of them were pale, not taking the stain properly. The tigroid granules were irregular in size and distribution, having lost their concentric arrangement around the nucleus.

The lung showed bronchopneumonic consolidations, hemorrhagic, with no fibrin in the exudate but wholly polymorphonuclear, and large desquamated vacuolated cells. In many alveoli purely red cells were found. There was also purulent bronchitis. The heart showed injection of the capillaries, intrafascicular and interfibrillar hemorrhages with myocardial degeneration. The findings in other organs were of congestion and a chronic inflammatory condition.

There was marked engorgement of the vessels of the pancreas and the adrenals. There was slight acute hemorrhagic tubuloglomerular nephritis with slight thickening of the media of the vessels. The spleen showed intense injection with minute interstitial hemorrhages, diminished pulp, atrophied malpighian corpuscles, and thick-walled vessels with hyaline degeneration. The liver showed moderate passive congestion, organizing focal degenerations with marked dilation and engorgement of the vessels and the sinusoids.

In view of the histological examination the pathological diagnosis of this case has been revised to include encephalitis lethargica.

The second case was a male Filipino, 17 years, who died after a 25-day stay in the hospital, with a clinical diagnosis of tuberculous meningitis (?). Autopsy performed four hours after death gave the following anatomical diagnosis: Encephalitis lethargica (?); congestion of all the viscera, marked; parenchymatous degeneration of liver and kidney, slight. Body, emaciated, presenting all the external evidences of an attack of a severe disease but, except for the marked passive congestion of, and the finding of petechial hemorrhages in, the viscera, together with capillary hemorrhages in the brain, the anatomical findings are absolutely negative.

Microscopically, sections of the brain presented the same marked engorgement of the vessels with distinct perivascular infiltration of small mononuclears and spilling of red cells into the perivascular spaces. In some of the vessels distinct rupture of the walls can be seen and the hemorrhages from them look irregular and more interstitial. Usually a portion of the wall was still preserved, in a few the wall was completely absent. The perivascularly infiltrating cells have maintained their relative position and indicate the boundaries or site of disappeared vessel walls. Here and there were minute, diffuse, irregular, interstitial hemorrhages. In most sections the extravascular blood was seen as minute dissecting hemorrhages about the intact vessels, which had evidently ruptured at some other level. Among these infiltrating cells there were occasionally present a few of the large mononuclear type. Hyaline thrombi were also seen. The spinal cord in this case showed no microscopic lesion.

There was much engorgement of the capillaries and vessels of all the viscera. In the lungs the alveoli were filled with red blood corpuscles in certain places. In the heart there were hemorrhages between the fibers. Anaërobic cultures from the brain and cord of these were made with negative results. Subdural injection of filtered and unfiltered emulsions from the brain, cord, and pharyngeal scrapings of these gave negative result. It may be of interest, particularly in view of reports of successful transmission of the infection to monkeys elsewhere, that the monkeys used here had been immunized with the so-called *Bacillus influenzæ* several months previously.

The third case came to the morgue with the clinical diagnosis of malaria, cerebral type, after staying in the hospital for fifteen days. Autopsy was performed by Doctor Wade, seven hours after death. Gross examination of the body revealed little to indicate the immediate cause of death. There was visceral congestion with superficial hemorrhages in the right lung and perivascular hemorrhages in the brain. Heart showed myocardial degeneration and dilatation. Because of these findings and our previous experience, a diagnosis of encephalitis lethargica was made.

Microscopically, as in the previous cases, there were found general marked vascular engorgement and, in the lungs, hemorrhages into the alveoli.

Sections of the brain at different levels presented the same microscopical picture as in the first case, except that engorgement, hemorrhages, and infiltration here appeared more intense.

The spinal cord, as in the first case, was affected and with considerable severity. The other viscera showed infection and slight degeneration.

In the kidneys there was marked tubular degeneration and slight epithelial desquamation with intratubular and intertubular hemorrhages, with enlargement of the alveoli, distension of the capsular space with serum, injection of the tuft, and slight mononuclear infiltration. Pancreas, spleen, and liver showed the same high degree of injection with widening of the sinusoids of the latter and slight degeneration of the parenchyma.

It is evident from the protocols of these three cases that the predominant picture in the pathology of this disease as represented by these cases is, essentially, marked visceral congestion and, histologically, minute capillary engorgement and hemorrhages of the brain and cord with distinct perivascular infiltration of small lymphocytes and occasionally some large mononuclears. In one of these cases there is, histologically, bronchopneumonia secondary to bronchitis, probably terminal in character, which does not much influence the clinical course of the disease, as it was not even noted on physical examination and in the clinical diagnosis. These vascular lesions may affect the whole extent of the nervous system or may localize and predominate in any portion of the brain or in the cord; for example, in the third case there is involvement both of the brain and of the cord simultaneously, with apparently the same intensity. The first, while affecting both structures, showed more profound changes in the brain. The second case, however, did not extend to the cord and, due to the fact that many of the brain sections in this case were negative, the lesions must have been only localized in a certain region, apparently in the region of the basal ganglia. In this connection it may be interesting to analyze some of the reports of other workers in different portions of the world.

Wegeforthy and Ayer(1) noted slight evidences in the cord of the cases they examined, but laid emphasis upon histological findings in sections of the brain; and Breinl,(2) of Australia, noting symptoms mostly referable to, and the pathological changes being mainly in, the cord, calls this mysterious disease "a clinically atypical form of Polyomyelitis."

On the other hand, Cleland,(3) also working in Australia, in his studies of an epidemic with marked cerebrospinal symptoms found the lesions much like those of cases 1 and 3, in which the brain and spinal cord were both heavily involved, and designated the disease "Epidemic Acute Encephalomyelitis."

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He is of the opinion that the virus of that particular epidemic which was successfully transmitted, and which reproduced lesions in monkeys, horses, and calf, may be a "mutant" of the virus that causes polyomyelitis and encephalitis lethargica.

Bassoe,(4) of Chicago, described a series in which the engorgement and perivascular infiltration were more localized and pronounced at the midbrain. Flexner(5) also found considerable involvement of the cord and brain.

It is scarcely necessary to remark that the microscopical findings of these and other workers are similar to our observations.

I am sorry that I cannot orientate from what definite portions of the brain each section was cut, but we always take sections of the different portions, including that of the basal ganglia and the peduncle.

It would seem then that, depending upon the portion of the brain or cord involved, the symptoms will vary and that the diagnosis will be a difficult matter clinically unless the disease appears in epidemic forms as it has lately done in other countries.

Just to illustrate this diagnostic difficulty for the clinician and even for the pathologist at the autopsy table, I will cite that during the short period following the discovery of its presence here we examined in all eight cases with which the connection of the diagnosis of encephalitis lethargica has been made, either clinically, at the time of autopsy, or later on histological examination.

The three cases here reported are included in these eight and, as you have heard, two of these three bore the clinical diagnosis of tuberculous meningitis, and one of the cerebral type of malaria. The first of the cases was diagnosed influenza at the table and subsequently found to be encephalitis on histological examination. The other two were diagnosed encephalitis with question mark, anatomically, but corroborated later microscopically. Three cases bore as one of the principal clinical diagnoses encephalitis lethargica, two of which turned out to be typhoid, and one tuberculous meningitis. Two of these were also provisionally diagnosed encephalitis anatomically, for possible association with other conditions found, but resulted negative microscopically.

Two others were diagnosed at the table probable encephalitis along with the other conditions present, on account of capillary congestion in the brain, but resulted negative histologically.

I presume that clinical diagnosis of isolated cases here, for reasons that are evident especially in this country and as borne out by an analysis of the diagnoses in this small series, will be doubly difficult due to the frequency of tuberculous meningitis, especially in children.

REFERENCES

1. Journ. Am. Med. Assoc. 73 (1919).
2. Med. Journ. Australia, 1 (1918).
3. Brit. Med. Journ. (May 13, 1919).
4. Journ. Am. Med. Assoc. 22 (1919).
5. Med. Rec. 96 (1919).

# THE PHILIPPINE JOURNAL OF SCIENCE

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## MILLABLE CANE IN THE PHILIPPINE ISLANDS

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ONE PLATE

In the Philippine Islands it frequently happens that cane of very low purity is sent to the factory. The actual cause of such low purity is of little importance to the manufacturer or the contracting planter. Often, however, the cane is so low in purity that it cannot be ground without loss to the central, and sometimes to both the central and the planter. When both are equal losers no controversy may arise, but if only the central is the loser a means should be devised by which it can refuse such cane.

Sometimes, when there is excellent planting weather, it may be advantageous to the planter to plant for his next crop, even though the mill cannot immediately handle the cane which furnishes the points; so that it often happens that the cane, having been cut for seed, remains in the field and starts its second growth, thus decreasing in purity. Should the cane be accidentally burned the purity would also be decreased, and in either case the material coming to the mill would be unfit for grinding. If such low-purity cane were milled separately, the rendement might be ascertained and the planter who furnished cane of a better class would not suffer. In actual practice, however, such separate milling cannot always be done; consequently, no stimulus is given for the production of better cane, and the result is that both the planter of the high grade and the central suffer considerable loss at the hands of the producer of low-grade cane. If the planter were willing to allow the factory to refuse his low-purity cane no loss might be entailed; but, should he insist upon its being milled on the contract basis, it must be ground, since the usual contract contains no proviso for the refusal of poor cane. The manufacturer must proceed with the work, even though he knows the cane to be poor. Obviously it would be to the advantage of all if a fair standard of purity were established, to serve as a basis for determining whether cane may be considered millable or not.

Cane, to be considered millable from the standpoint of the central, should be of such sucrose content and purity that the central can work it into sugar and molasses with the equipment on hand, without being compelled to resort to remelting, special processes, or the purchase of extra machinery. From juices extracted from millable cane it should be possible to produce 96° sugar or better, and a molasses showing an average purity. Obviously cane showing a purity of only 60 per cent for the mixed juice will not, by itself, produce in one operation a standard 96° sugar; the sugar resulting after leaving the crystallizer and the centrifugals will have to be remelted or, if a good grade is obtained, it will at least have to be mixed with a higher-grade molasses for further conversion into a standard centrifugal sugar. This procedure not only complicates the work, but also increases the cost of manufacture and, therefore, reduces the profits to the central.

In determining a fair standard for millable cane the purity of the juice is not the sole factor to be taken into consideration. For example, a juice with a Brix of 10° and a purity of 80 per cent will give a rendement of 5.76 per cent, while a juice with a Brix of 15° and the same purity, will give a rendement of 8.66 per cent. Both juices mentioned are equally millable. However, the cost of transportation of the cane per ton of sugar is much greater in the first case than in the second, and the steam consumption for evaporation of the first juice is considerably greater. Therefore, there should be adopted also a minimum for the degrees Brix.

A modern factory making a 96° sugar will adopt the three-boiling system, this being the most economical and the easiest. The purities maintained will be: for the first boiling, 80 per cent; for the second, 70; and for the third, 60. These purities are obtained by boiling straight sirup to grain, and then adding molasses from former strikes so as to obtain the required purities in the finished massecuites. The purity of the sirup should not fall below 70 per cent. I am fully aware that, as a rule, a cane of such low purity will not come to the mills; however, I have seen cane come to the central the first mill juice of which was of 38 per cent purity. This was badly burned cane which had been left in the field for a month. When the sirup has a purity of 70 per cent, the first boiling is omitted and only the two-boiling system is employed. By washing we can then obtain a 96° sugar from the resulting massecuite. Generally, where the purity drops below 70 per cent, the massecuite will not produce a good 96° sugar and the product will have to be remelted which will require the use of extra pan capacity and entail extra cost. I have adopted as a basis the minima of 15° and 70 per cent, respectively, for Brix and purity.

The available sugar in a ton of cane is then 6.97 per cent and it takes 14.35 tons of cane to make a ton of sugar. From the manufacturing standpoint alone such a cane can be handled; however, financially it may be undesirable to handle. In this connection the following items to be considered are enumerated:

1. Cost of transportation per ton of cane.
2. Cost of manufacture per ton of sugar.
3. At lower rendement, extra cost for items 1 and 2.
4. Overhead charges per day.
5. Capacity of mill or tons of cane ground per day.

Allowing a central or a plantation company a net profit of 40 per cent over the cost of manufacture, I have worked all these items into the following formula:

$$1.4\ \left(10t + C + x\,[t + 1.20] + \frac{\frac{O}{\text{Cap.}}}{10 + x}\right) = \tfrac{1}{2}\,P.$$

t = Cost of transportation per ton of cane.
C = Cost of manufacture per ton of sugar.
O = Overhead charges per day.
Cap. = Capacity of mill or tons of cane ground per day.
P = Net proceeds at marketing place of the sugar.

In the formula, I have added 1.20 pesos to the manufacturing cost for every ton of cane over 10 required to make a ton of sugar. The mean higher cost of manufacture comes to this figure, calculated from actual data that I have on record.

Assuming the following data:

t = 50 centavos,
C = 20 pesos, at 10 to 1,
O = 300 pesos,
Cap. = 600 tons,
P = 140 pesos per ton of sugar,

and applying these figures to the formula, leaving $x$ unknown we get $x=9$. This means that it may take 9 more than 10 tons, or 19 tons, of cane per ton of sugar, without reducing the net profit—namely 40 per cent.

For different net proceeds ranging from 80 pesos to 220 pesos, Table 1 shows the amount of cane (in tons) that mills of various capacities may require in order to make the stipulated profit. The capacities range from 150 to 600 tons per day.

TABLE 1.—*Number of tons of cane necessary to obtain net proceeds of from 80 to 220 pesos in mills of from 150 to 600 tons per day capacity.*

| Capacity. | Net proceeds in pesos. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
| *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 150 | 5.56 | 6.53 | 7.49 | 8.46 | 9.43 | 10.39 | 11.35 | 12.30 |
| 200 | 6.43 | 7.55 | 8.66 | 9.78 | 10.89 | 12.01 | 13.13 | 14.25 |
| 250 | 7.10 | 8.33 | 9.60 | 10.79 | 12.02 | 13.25 | 14.48 | 15.71 |
| 300 | 7.62 | 8.94 | 10.26 | 11.59 | 12.92 | 14.25 | 15.58 | 16.91 |
| 350 | 8.05 | 9.44 | 10.84 | 12.24 | 13.64 | 15.04 | 16.44 | 17.84 |
| 400 | 8.40 | 9.86 | 11.31 | 12.76 | 14.21 | 15.66 | 17.11 | 18.56 |
| 450 | 8.68 | 10.18 | 11.68 | 13.18 | 14.68 | 16.18 | 17.68 | 19.18 |
| 500 | 8.94 | 10.49 | 12.04 | 13.59 | 15.14 | 10.69 | 18.24 | 19.79 |
| 550 | 9.16 | 10.75 | 12.34 | 13.93 | 15.52 | 17.11 | 18.70 | 20.29 |
| 600 | 9.8 | 11.0 | 12.5 | 14.2 | 15.8 | 17.4 | 19.0 | 20.7 |

| Capacity. | Net proceeds in pesos. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 160 | 170 | 180 | 190 | 200 | 210 | 220 |
| *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 150 | 13.26 | 14.20 | 15.17 | 16.12 | 17.08 | 18.03 | 18.99 |
| 200 | 15.37 | 16.49 | 17.61 | 18.73 | 19.85 | 20.97 | 22.09 |
| 250 | 16.94 | 18.17 | 19.40 | 20.66 | 21.86 | 23.09 | 24.32 |
| 300 | 18.24 | 19.57 | 20.9 | 22.23 | 23.56 | 24.89 | 26.22 |
| 350 | 19.24 | 20.64 | 22.04 | 23.44 | 24.84 | 26.24 | 27.64 |
| 400 | 20.01 | 21.46 | 22.91 | 24.36 | 25.81 | 27.26 | 28.71 |
| 450 | 20.68 | 22.18 | 23.68 | 25.18 | 26.68 | 28.18 | 29.68 |
| 500 | 21.34 | 22.89 | 34.44 | 25.99 | 27.54 | 29.09 | 30.64 |
| 550 | 21.88 | 23.47 | 25.06 | 26.65 | 28.24 | 29.83 | 31.42 |
| 600 | 22.3 | 24.0 | 25.6 | 27.2 | 28.8 | 30.4 | 32.00 |

For a factory working at full capacity the rendement allowable depends upon the net proceeds from the sugar. However, there is the possibility that a factory cannot be run continually at full capacity, owing to various causes; such as a breakdown in the mill, rains, lack of labor, transportation difficulties, and fires. If for any of these reasons the capacity is cut in half, by again using the formula but now adopting 300 tons as capacity, the allowable rendement will be shown to be 15.58 tons against 19 tons as before. The figure of 15.58 is dangerously near the minimum set, namely, 14.35 tons of cane per ton of sugar. The formula also permits the manufacturer to calculate the minimum quantity of a certain cane that must be milled per day in order to make the set profit. Thus the question whether grinding should or should not proceed depends upon net proceeds and capacity (the amount of cane ground in twenty-four hours); and these two factors, namely, net proceeds and capacity, control the rendement allowable. The smaller the capacity of the central, or the smaller the quantity of cane ground per day in a central of any capacity, the higher the rendement must be. For instance, Tables 1 and 2 show that, if the juice has 15° Brix and a purity of 70 per cent, at least 245 tons will have to be ground daily in order to make the stipulated 40 per cent profit. Any manufacturer can calculate from this formula whether or not he can grind profitably under conditions as they exist in his central. The graphic chart (Plate 1) shows the figures much more plainly than does the table.

This chart is useful in many ways. Assuming that the net proceeds per ton of sugar amount to 140 pesos and that the capacity of the central is 600 tons of cane, the lines indicating these numbers cross at 19, showing that this is the number of tons of cane it will take to make 1 ton of sugar in order to clear the stipulated 40 per cent profit. Assuming the net proceeds and the rendement of the cane to be 160 pesos and 12 tons, respectively, we find that the line on the chart showing the lowest capacity is still well above the crossing of these two lines; which means that, if the mill grinds even less than 150 tons of cane per day, it can still make the 40 per cent profit. On the other hand, with net proceeds of 140 pesos and a rendement of 14 tons, milling would have to be done at a rate of about 250 tons; with 130 pesos and 14 tons rendement, 300 tons; and with the same net proceeds and 15 tons rendement, it must grind at least 350 tons per day. In other words, the poorer the cane the faster must grinding be done. Up to a certain point this can be regulated in actual practice since mill capacity, depending as it does upon the size of the boiling house, is fairly elastic. If the boiling house is slightly larger than is specified by the capacity of the mill, a decided advantage is gained.

As far as establishing a standard for purity is concerned it is clear that it is possible to grind a cane of a purity lower than 70 per cent, since the higher-grade cane coming in at the same time offsets this low purity; but mixed grinding can be done only to a certain extent, as such a procedure would tend to overfill the boiling house with low-grade sugar products, while the crystallizer capacity would soon be exceeded. However, the amount of low-grade sugar produced will be the same in the end whether the low-purity juice comes in mixed with the better juice or separate. If two cane fields are being cut at the same time, the cane from the one showing a high-purity juice, and that from the other a low-purity juice, both canes will have to be accepted by the central, so long as the mean purity does not fall below 70 per cent. It is not advisable to grind cane giving a 70 per cent purity for, say, one week and then to begin grinding cane of a higher purity, because the great number of lower boilings might keep the crystallizers and centrifugals occupied so long that the working of the factory would be blocked. Many modern centrals provide crystallizers only, but no special tanks for low-grade blank strikes. Under ordinary circumstances special tanks will not be needed, but when a large quantity of low-purity juice comes to a factory it will prove an advantage to have them; for then good sirup will not need to be mixed with molasses from a poor juice which usually not only is low in purity, but also is hard to handle mechanically.

The molasses from a poor juice is simply brought to string proof and sent to the massecuite storage tanks, each tank holding one strike. These storage tanks are continually kept filled until a holiday occurs, or until the end of the grinding season; then they are emptied, the massecuite is spun, and the resulting low-grade sugar is remelted.

The foregoing remarks serve to lead up to the question of what should be done with cane of low purity. Almost invariably the planter who has his cane milled by the central on a percentage basis thinks that he should derive a certain profit from it. I well remember one instance when cane came to the factory that gave a first mill juice of 38 per cent purity. This was an extreme case, which would undoubtedly happen but once in a lifetime. But when cane with a purity of from 55 to 65 per cent comes to the mill day after day, with only a very small quantity of good cane to offset it, the question arises whether the central may refuse to mill such cane or whether some use cannot be found for it which might offset the loss that undoubtedly would occur in milling it for sugar. So far as I know, there is at present in the Philippines no central that allows the planter an interest in the molasses, and the peculiar fact exists that a very poor cane will only pay for its transportation when converted into molasses. In fact it will pay for its transportation more readily than good cane, naturally assuming that the molasses is sold. In Table 2, I have put this fact in figures which are self-explanatory.

**TABLE 2.**—*Showing values gained from the utilization of juice for the manufacture of molasses*[a] *and of alcohol.*[b]

| Brix. | Value of alcohol per ton of sugar. | Average rendement molasses. | Cane per ton of sugar. | Transportation cost per ton of sugar. | Molasses per ton of sugar. | Value of molasses per ton of cane. | Value of molasses per ton of sugar. | Available 180° alcohol per ton of cane. | 180° proof alcohol per ton of cane. | Value of alcohol per ton of cane. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Pesos.* | *P. ct.* | *Tons.* | *Pesos.* | *Lbs.* | *Pesos.* | *Pesos.* | *P. ct.* | *Lbs.* | *Pesos.* |
| **70 PER CENT PURITY.** | | | | | | | | | | |
| 15 | 49.22 | 5.32 | 14.33 | 7.17 | 106 | 0.53 | 7.60 | 1.18 | 23.6 | 3.43 |
| 16 | 52.57 | 6.04 | 13.48 | 6.74 | 121 | 0.605 | 8.15 | 1.34 | 26.8 | 3.90 |
| 17 | 52.28 | 6.37 | 12.69 | 6.34 | 127 | 0.635 | 8.05 | 1.41 | 28.2 | 4.12 |
| 18 | 53.80 | 6.89 | 11.93 | 5.96 | 138 | 0.690 | 8.23 | 1.53 | 30.6 | 4.45 |
| 19 | 52.25 | 7.17 | 11.31 | 5.65 | 143 | 0.715 | 8.08 | 1.59 | 31.8 | 4.62 |
| 20 | 56.26 | 7.54 | 10.77 | 5.38 | 150 | 0.750 | 8.08 | 1.67 | 33.4 | 4.85 |
| 21 | 52.48 | 7.92 | 10.27 | 5.13 | 158 | 0.790 | 8.11 | 1.76 | 35.2 | 5.11 |
| 22 | 52.21 | 8.30 | 9.76 | 4.88 | 166 | 0.830 | 8.10 | 1.84 | 36.8 | 5.35 |
| **80 PER CENT PURITY.** | | | | | | | | | | |
| 15 | 24.25 | 3.57 | 11.55 | 5.77 | 71 | 0.35 | 4.16 | 0.79 | 15.8 | 2.30 |
| 16 | 26.47 | 3.80 | 10.85 | 5.42 | 76 | 0.38 | 4.12 | 0.84 | 16.8 | 2.44 |
| 17 | 26.34 | 4.03 | 10.21 | 5.10 | 80 | 0.40 | 4.08 | 0.89 | 17.8 | 2.53 |
| 18 | 26.28 | 4.26 | 9.63 | 4.81 | 85 | 0.42 | 4.18 | 0.94 | 18.8 | 2.73 |
| 19 | 26.59 | 4.50 | 9.14 | 4.57 | 90 | 0.45 | 4.09 | 1.00 | 20.0 | 2.91 |
| 20 | 26.41 | 4.73 | 8.66 | 4.33 | 95 | 0.47 | 4.06 | 1.05 | 21.0 | 3.05 |
| 21 | 26.40 | 4.96 | 8.26 | 4.13 | 99 | 0.50 | 4.05 | 1.10 | 22.0 | 3.20 |
| 22 | 26.43 | 5.19 | 7.89 | 3.94 | 104 | 0.52 | 4.09 | 1.15 | 23.0 | 3.35 |
| **90 PER CENT PURITY.** | | | | | | | | | | |
| 15 | 9.29 | 1.47 | 9.68 | 4.84 | 29 | 0.14 | 1.35 | 0.33 | 6.6 | 0.96 |
| 16 | 9.25 | 1.57 | 9.07 | 4.53 | 31 | 0.15 | 1.36 | 0.35 | 7.0 | 1.62 |
| 17 | 9.14 | 1.67 | 8.54 | 4.27 | 33 | 0.16 | 1.37 | 0.37 | 7.4 | 1.07 |
| 18 | 9.11 | 1.77 | 8.07 | 4.03 | 35 | 0.17 | 1.37 | 0.39 | 7.8 | 1.13 |
| 19 | 9.09 | 1.87 | 7.64 | 3.82 | 37 | 0.18 | 1.38 | 0.41 | 8.2 | 1.19 |
| 20 | 9.30 | 1.97 | 7.27 | 3.63 | 39 | 0.19 | 1.38 | 0.44 | 8.8 | 1.28 |
| 21 | 9.19 | 2.07 | 6.91 | 3.45 | 41 | 0.20 | 1.38 | 0.46 | 9.2 | 1.33 |
| 22 | 9.27 | 2.17 | 6.60 | 3.30 | 43 | 0.21 | 1.39 | 0.48 | 9.6 | 1.39 |

[a] Value of molasses per pound is 0.005 peso (0.06 peso a gallon; now, February, 1920, 0.30 peso; 1 gallon=12 pounds.)

[b] Value of alcohol per gallon is 1 peso; per pound, 0.1455 peso.

In the case of poor cane it is clear that the planter is the one who suffers most, as he gets no returns for raising, cutting, and loading it, while the factory can at least clear the cost of transportation. In fact, I should be inclined to consider whether it might not pay to work up poor cane for its molasses yield, rather than in the manufacture of sugar. Molasses would then become one of the main products, although still a by-product.

Naturally, when good cane is available, cane that yields juice of too low a purity should not be allowed to be milled together with the better grade, since it is almost impossible, under ordinary circumstances, to keep the juices separate. If the factory would decide to give the planter an interest in the molasses, or in any of the products made from molasses, such as alcohol, conditions would be greatly altered. The planter should be allowed an interest in the by-products, for the reason that molasses contains most of the soluble salts, of which potash forms about 2.5 per cent of the weight of the molasses. This potash is the most valuable constituent taken from the soil by the cane, and unless returned to it the soil becomes impoverished. When the molasses is burned in conjunction with the bagasse, most of the potash can be recovered, and this should be given to the planter for fertilization purposes. The planter should be required to pay the cost of loading and hauling. In practice much of the potash is lost, due to the fact that the furnace is maintained at too high a temperature, which fact is betrayed when the top of the smoke stack of the factory shows white.

In Table 2 are shown the values of the molasses when made into denatured alcohol, taking alcohol at 1 peso per gallon, or about 14 centavos per pound. The table also shows that a fair amount of money can be recovered from the molasses. As a rule, a well-equipped, modern central will be able to run its distillery without interfering with the operation of the boiling house and mill. There should be no lack of steam and, if the cane contains from 11.5 to 13 per cent of fiber, sufficient bagasse fuel should be on hand to run the distillery also. The table shows that the poorer the cane, the more valuable the molasses, the yields being as high as 53.80 pesos per ton of available sugar in one instance when expressed as alcohol, while the molasses itself represents a value of only about 8.23 pesos when sold as such at 6 centavos per gallon. If we take 12 centavos as the value of the molasses per gallon, a ton of available sugar would yield in molasses only 16.46 pesos, or 37.34 pesos less per ton of sugar when sold as molasses than when sold as alcohol.

In the process of manufacturing alcohol from molasses the waste from the distillery still contains potash, as well as nitrogen and phosphoric acid, which can be returned to the field, either in liquid form by irrigation or in solid form after drying the material in the sun.

Assuming a factory production of 10,000 tons of sugar per year from a juice with 19° Brix and 80 per cent purity, the molasses produced would be 4.5 per cent of the weight of the cane. Therefore, assuming the potash content of the molasses to be 2.5 per cent, the potash would represent (the cane weighing 91,400 tons) 102.825 tons with a value of about 200 pesos per ton (pre-war price), or a total value for the crop of 20,565 pesos. The alcohol would be worth 205,900 pesos; the sugar at say 200 pesos per ton, 2,000,000 pesos; total value of the crop, 2,286,465 pesos. If the molasses were sold as such, we should have:

| | Pesos. |
|---|---|
| Value of crop at 200 pesos per ton | 2,000,000 |
| Value of molasses | 40,900 |
| Total value | 2,040,900 |

Therefore, the difference in value is 245,565 pesos in favor of working up the molasses into alcohol and potash. In this case I have calculated values at pre-war market prices. Each factory can figure out for itself whether or not it would pay to work up this material. As I have pointed out in another paper, not yet in print, the alcohol could be used in tractors or motors on the plantation; and the carbon dioxide coming from the fermentation vats could be employed in making plantation white sugar and, where there is access to cool well water, in making ice. The value of the potash is a paper value, since it should be returned to the field as a fertilizer, so as to keep the field in proper condition.

If the molasses is converted into alcohol so little of the former will be wasted that I cannot see how this use of it could fail to yield an excellent profit, and the question of profitable utilization of low-purity cane would seem to be answered.

For convenience I am adding Table 3, showing values at the same purities as in Table 2, giving approximate values of the potash per ton of cane at 200 pesos per ton for the potash.

In Table 4 are given values per hectare (the crop estimated at 50 tons of cane per hectare), showing the difference in value when the product is sold as sugar and molasses, as is done now, and its value when sold as sugar, alcohol, and potash. With a juice of 18.5° Brix and 85 per cent purity the central now receives 15.25 pesos per hectare for the molasses against 114.90 pesos per hectare when worked up into alcohol and potash.

In conclusion, it seems to me feasible to install a central distillery capable of working up all the molasses produced, and to give the planter an opportunity to own a half interest. Even under such conditions the central will net more than under the present way of working up the molasses, or by selling it direct.

TABLE 3.—*Approximate values of potash per ton of cane yielding juices of varying purity.*

| Brix. | Molasses rendement. | Potash rendement. | Potash. | Value. |
|---|---|---|---|---|
| PURITY, 70 PER CENT. | | | | |
| | *Per cent.* | *Per cent.* | *Lbs.* | *Pesos.* |
| 15 | 5.32 | 0.133 | 2.66 | 0.532 |
| 16 | 6.04 | 0.151 | 3.02 | 0.604 |
| 17 | 6.37 | 0.159 | 3.18 | 0.636 |
| 18 | 6.89 | 0.172 | 3.44 | 0.688 |
| 19 | 7.17 | 0.179 | 3.58 | 0.716 |
| 20 | 7.54 | 0.188 | 3.76 | 0.752 |
| 21 | 7.92 | 0.198 | 3.96 | 0.792 |
| 22 | 8.30 | 0.207 | 4.14 | 0.828 |
| PURITY, 80 PER CENT. | | | | |
| 15 | 3.57 | 0.089 | 1.78 | 0.356 |
| 16 | 3.80 | 0.095 | 1.90 | 0.380 |
| 17 | 4.08 | 0.101 | 2.02 | 0.404 |
| 18 | 4.26 | 0.106 | 2.12 | 0.424 |
| 19 | 4.50 | 0.112 | 2.24 | 0.448 |
| 20 | 4.73 | 0.118 | 2.36 | 0.472 |
| 21 | 4.96 | 0.124 | 2.48 | 0.496 |
| 22 | 5.19 | 0.129 | 2.58 | 0.516 |
| PURITY, 90 PER CENT. | | | | |
| 15 | 1.47 | 0.037 | 0.74 | 0.148 |
| 16 | 1.57 | 0.039 | 0.78 | 0.156 |
| 17 | 1.67 | 0.041 | 0.82 | 0.164 |
| 18 | 1.77 | 0.044 | 0.88 | 0.176 |
| 19 | 1.87 | 0.046 | 0.92 | 0.184 |
| 20 | 1.97 | 0.049 | 0.98 | 0.196 |
| 21 | 2.07 | 0.052 | 1.04 | 0.208 |
| 22 | 2.17 | 0.054 | 1.08 | 0.216 |

**TABLE 4.**—*Values of product when sold as sugar and molasses and when sold as sugar, alcohol, and potash, based on an estimated crop of 50 tons of cane per hectare.*[a]

| Brix. | Sugar. | Value of sugar. | Value of molasses. | Value of alcohol. | Value of potash. | Total value of sugar and molasses. | Total value of sugar, alcohol, and potash. |
|---|---|---|---|---|---|---|---|
| PURITY, 70 PER CENT. | | | | | | | |
| | *Tons.* | *Pesos.* | *Pesos.* | *Pesos.* | *Pesos.* | *Pesos.* | *Pesos.* |
| 15 | 3.484 | 696.80 | 26.50 | 171.50 | 16.60 | 723.30 | 884.90 |
| 16 | 3.709 | 741.80 | 30.25 | 195.00 | 24.20 | 772.05 | 961.00 |
| 17 | 3.941 | 788.20 | 31.75 | 206.00 | 31.80 | 819.95 | 1,026.00 |
| 18 | 4.191 | 838.20 | 34.50 | 252.50 | 34.40 | 872.70 | 1,095.10 |
| 19 | 4.422 | 884.40 | 35.75 | 231.00 | 35.80 | 920.15 | 1,151.20 |
| 20 | 4.646 | 929.20 | 37.50 | 242.50 | 37.60 | 966.70 | 1,205.30 |
| 21 | 4.869 | 973.80 | 39.50 | 255.50 | 39.60 | 1,013.30 | 1,268.90 |
| 22 | 5.123 | 1,024.60 | 41.50 | 268.50 | 41.40 | 1,066.10 | 1,334.50 |
| **Mean** | | | | | | 896.42 | 1,123.15 |
| PURITY, 80 PER CENT. | | | | | | | |
| 15 | 4.322 | 864.40 | 17.50 | 115.00 | 17.80 | 881.90 | 997.20 |
| 16 | 4.609 | 921.80 | 19.00 | 122.00 | 19.00 | 940.80 | 1,062.80 |
| 17 | 4.896 | 979.20 | 20.00 | 129.00 | 20.20 | 999.20 | 1,128.40 |
| 18 | 5.192 | 1,038.40 | 21.00 | 136.50 | 21.20 | 1,059.40 | 1,196.10 |
| 19 | 5.470 | 1,094.00 | 22.50 | 145.50 | 22.40 | 1,116.50 | 1,261.90 |
| 20 | 5.772 | 1,154.40 | 23.50 | 152.50 | 23.60 | 1,177.90 | 1,330.50 |
| 21 | 6.054 | 1,210.80 | 25.00 | 160.00 | 24.80 | 1,235.80 | 1,395.60 |
| 22 | 6.336 | 1,267.20 | 26.00 | 167.50 | 25.80 | 1,298.20 | 1,460.50 |
| **Mean** | | | | | | 1,087.95 | 1,229.00 |
| PURITY, 90 PER CENT. | | | | | | | |
| 15 | 5.165 | 1,038.00 | 7.00 | 48.00 | 7.40 | 1,040.00 | 1,088.40 |
| 16 | 5.513 | 1,102.60 | 7.50 | 51.00 | 7.80 | 1,110.40 | 1,161.40 |
| 17 | 5.855 | 1,171.00 | 8.00 | 53.50 | 8.20 | 1,179.00 | 1,232.70 |
| 18 | 6.196 | 1,239.20 | 8.50 | 56.50 | 8.80 | 1,247.70 | 1,304.50 |
| 19 | 6.544 | 1,308.80 | 9.00 | 59.50 | 9.20 | 1,317.80 | 1,377.50 |
| 20 | 6.878 | 1,375.60 | 9.50 | 64.00 | 9.80 | 1,385.10 | 1,449.40 |
| 21 | 7.236 | 1,447.20 | 10.00 | 66.50 | 10.40 | 1,457.20 | 1,524.10 |
| 22 | 7.575 | 1,515.00 | 10.50 | 69.50 | 10.80 | 1,525.50 | 1,595.80 |
| **Mean** | | | | | | 1,282.75 | 1,341.00 |

[a] Ton of sugar, value 200 pesos; ton of potash, value 200 pesos; 1 gallon of 180° denatured alcohol, value 1 peso. Total difference for a cane giving a juice with Brix of 18.5° and purity of 85 per cent when the product is sold as sugar and molasses and when it is sold as sugar, alcohol, and potash is 99.65 pesos per hectare.

# ILLUSTRATION

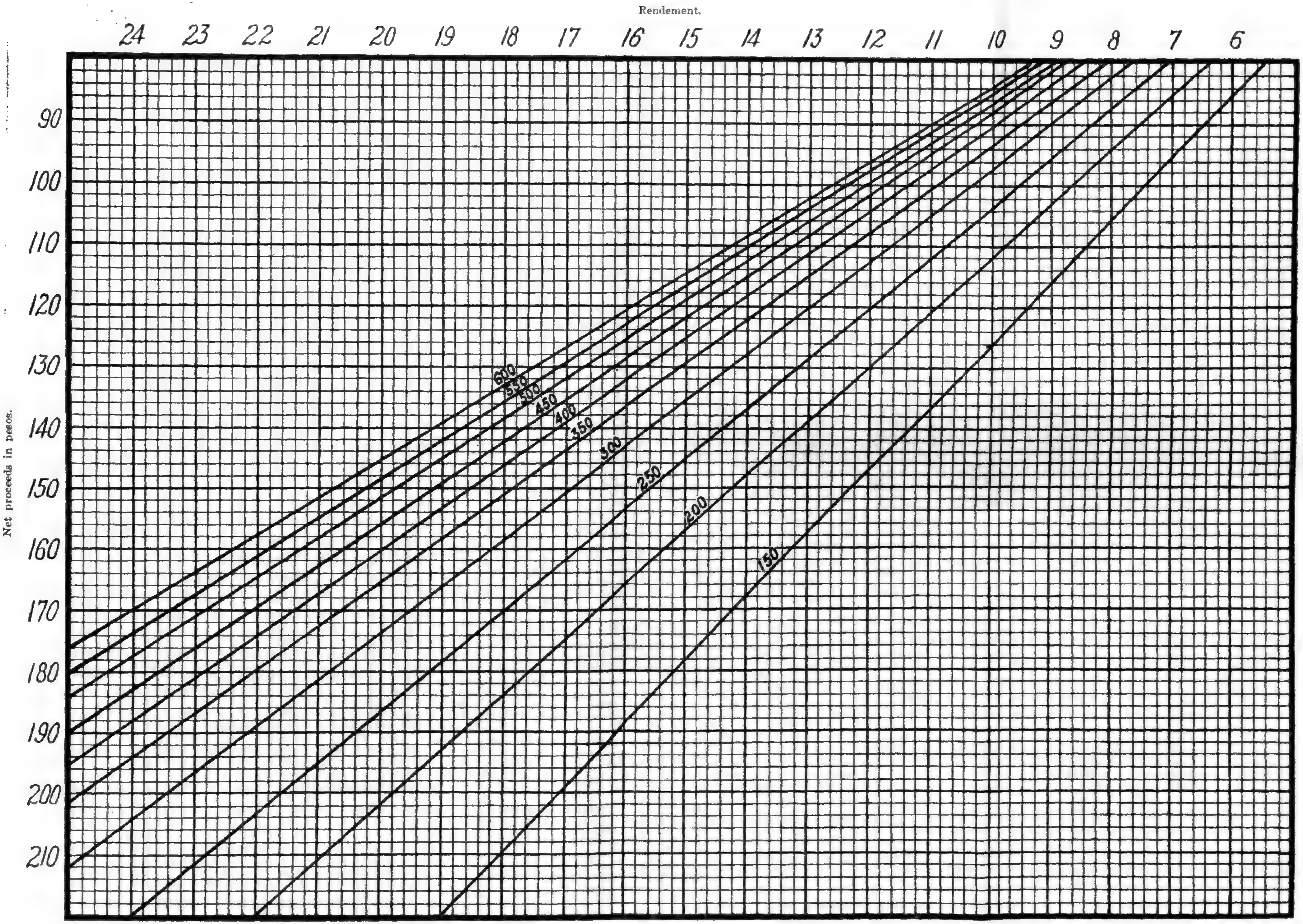


PLATE 1. SHOWING RELATIONSHIP BETWEEN RENDEMENT, NET PROCEEDS, AND CAPACITY.

# THE NONDIASPINE COCCIDÆ OF THE PHILIPPINE ISLANDS, WITH DESCRIPTIONS OF APPARENTLY NEW SPECIES [1]

By Harold Morrison

*Of the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.*

ONE PLATE AND FORTY TEXT FIGURES

Under the title Coccidæ of the Philippine Islands,[2] Miss Elizabeth Robinson published in 1917 an account of the species of the Coccidæ then known from the Islands, and described some new species in the family, subfamily Diaspinæ. In the meantime and subsequently I have received or obtained a considerable number of lots of material of the nondiaspine subfamilies for study, mostly through sendings of specimens for determination to Dr. L. O. Howard, chief of the Bureau of Entomology; and I have also worked over the specimens from the Philippines now in the United States National collection of Coccidæ with the result that a number of species have been added to the list hitherto known from the Philippines, and through the opportunity for examining type specimens of a number of the species, different conclusions from those of Miss Robinson in regard to the identity of several of the species listed by her have been reached. In view of the large amount of material examined and the changes in synonymy and identity noted, it has been considered advisable to prepare a paper covering the nondiaspine species of the family in their entirety, even where no new information is added to that given by Miss Robinson. This paper is supplementary to hers to the extent that no host or distribution records given by her are repeated.

I am indebted to Prof. T. D. A. Cockerell, Mr. D. B. Mackie, Mr. R. C. McGregor, Prof. C. F. Baker, Mr. Geo. Compere, and, through the Director of the Philippine Bureau of Science, Prof. C. S. Banks for material for study from the Islands. No effort

[1] Published with the permission of the Secretary, United States Department of Agriculture.

[2] Philip. Journ. Sci. § D 12 (1917) 1–47, pls. 1–6.

has been made to check the localities listed exactly, but it is believed that most of the specimens are from Luzon. The data regarding the host, date of collection, locality, and name of collector have been copied, so far as possible, exactly as given with the different lots of material.[3]

The specimens have been prepared for microscopic study largely by Misses B. M. Boss and Sadie Keen, employees of the Bureau of Entomology. The drawings illustrating the structural characteristics of the species have been prepared by Emily Morrison, who also aided in the preparation of the photographic illustrations and in many other ways. To these I am correspondingly indebted.

Although obviously unsatisfactory in a number of ways, the system of classification outlined by Fernald [4] has been followed, except in a few unimportant details.

Unless some statement to the contrary is made, all of the identification keys which follow in this paper are based on the adult female of each species.

*Key to the Philippine subfamilies of the Coccidæ.*

$a^1$. Abdomen not terminating in a compound segment or pygidium; body naked or covered by secretion or a sac, not by a firm waxy scale separable from the insect; legs and antennæ usually, but not always present.

$b^1$. Anal opening at the apex of prominent dorsal lobe, with a spiniform organ between it and a pair of spiracular processes; anal ring with setæ; legs wanting; antennæ rudimentary; body inclosed in a resinous cell with three orifices (cf. *Ceroplastes*). **Tachardiinæ.**

$b^2$. Anal opening not so placed (on chitinized horn in *Ceroplastes*); body without spiniform organ or spiracular processes; not inclosed in a resinous cell with three orifices.

$c^1$. With two or more pairs of abdominal spiracles; anal ring without setæ, placed dorsally some distance before the body apex and not at the end of a cleft, circular, not covered by triangular plates; body usually thickly set with large hairs and circular gland pores.......... **Monophlebinæ.**

$c^2$. Without abdominal spiracles; anal ring normally bearing setæ, placed at or close to the body apex or, if dorsally, at the anterior end of a cleft in the body.

[3] Some evident errors in names of localities have been corrected.—THE EDITORS.

[4] A Catalogue of the Coccidae of the world, Bull. Hatch Exp. Sta. Mass. Agr. College **88** (1903).

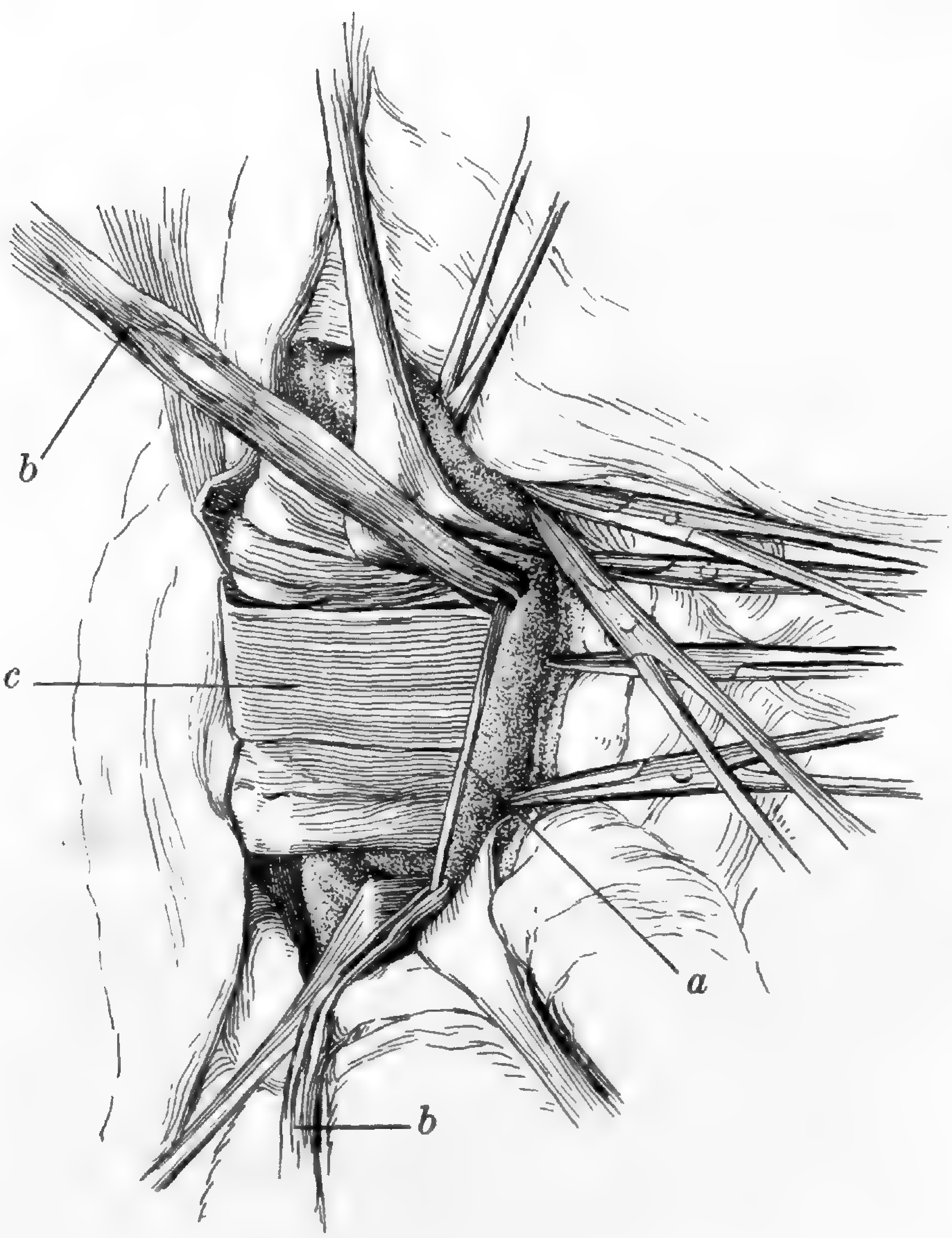


PLATE 1.

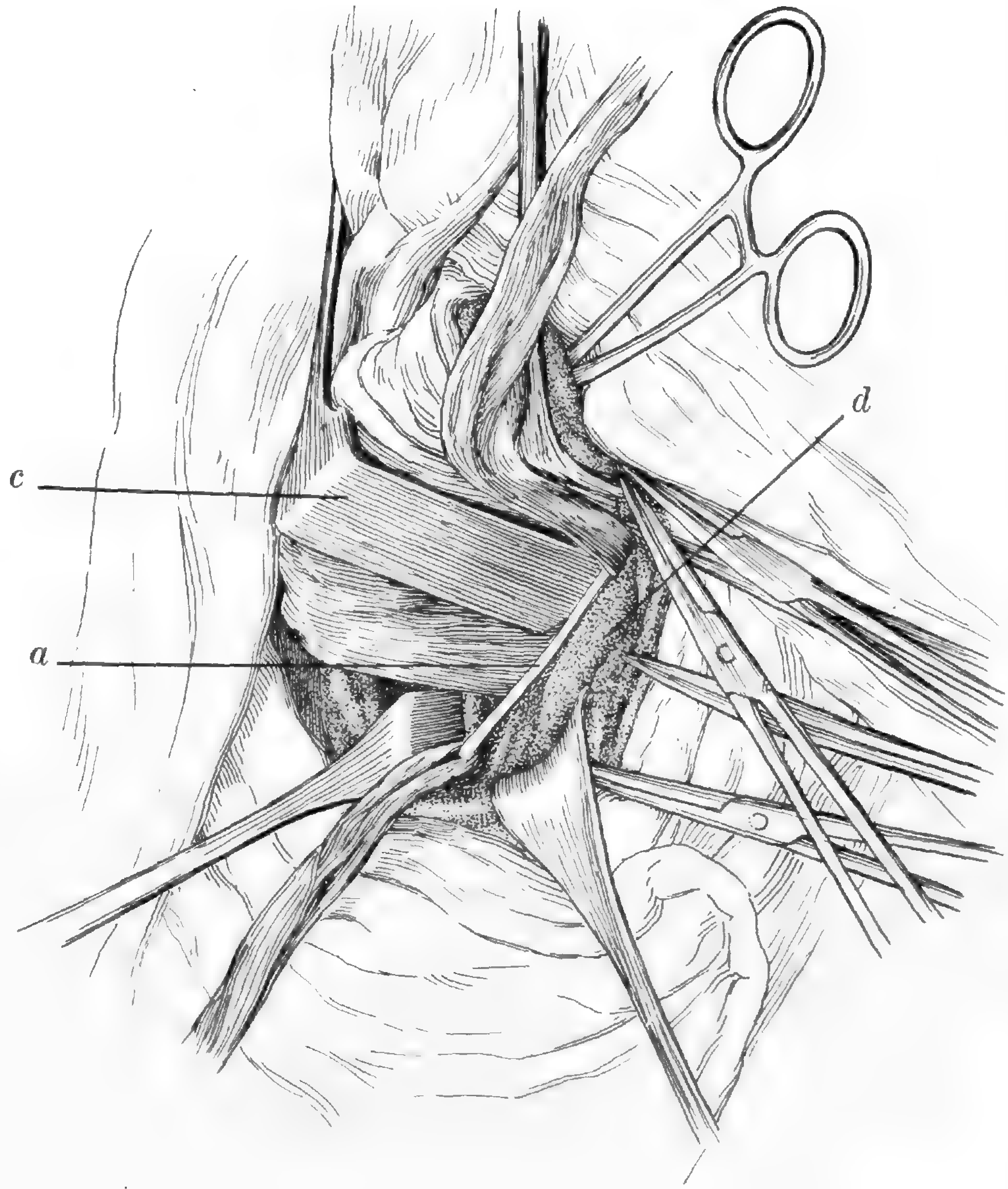


PLATE 2.

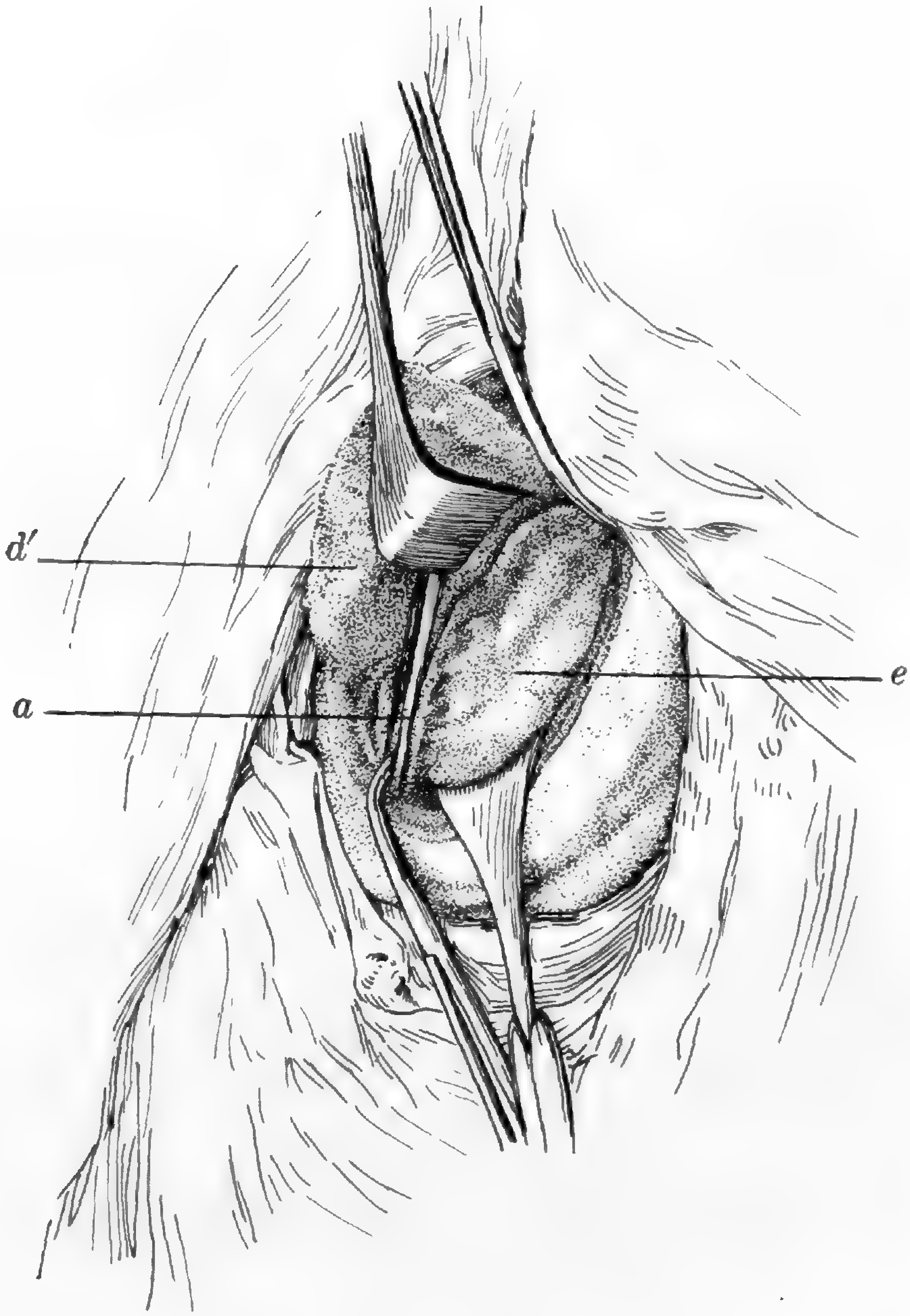


PLATE 3.

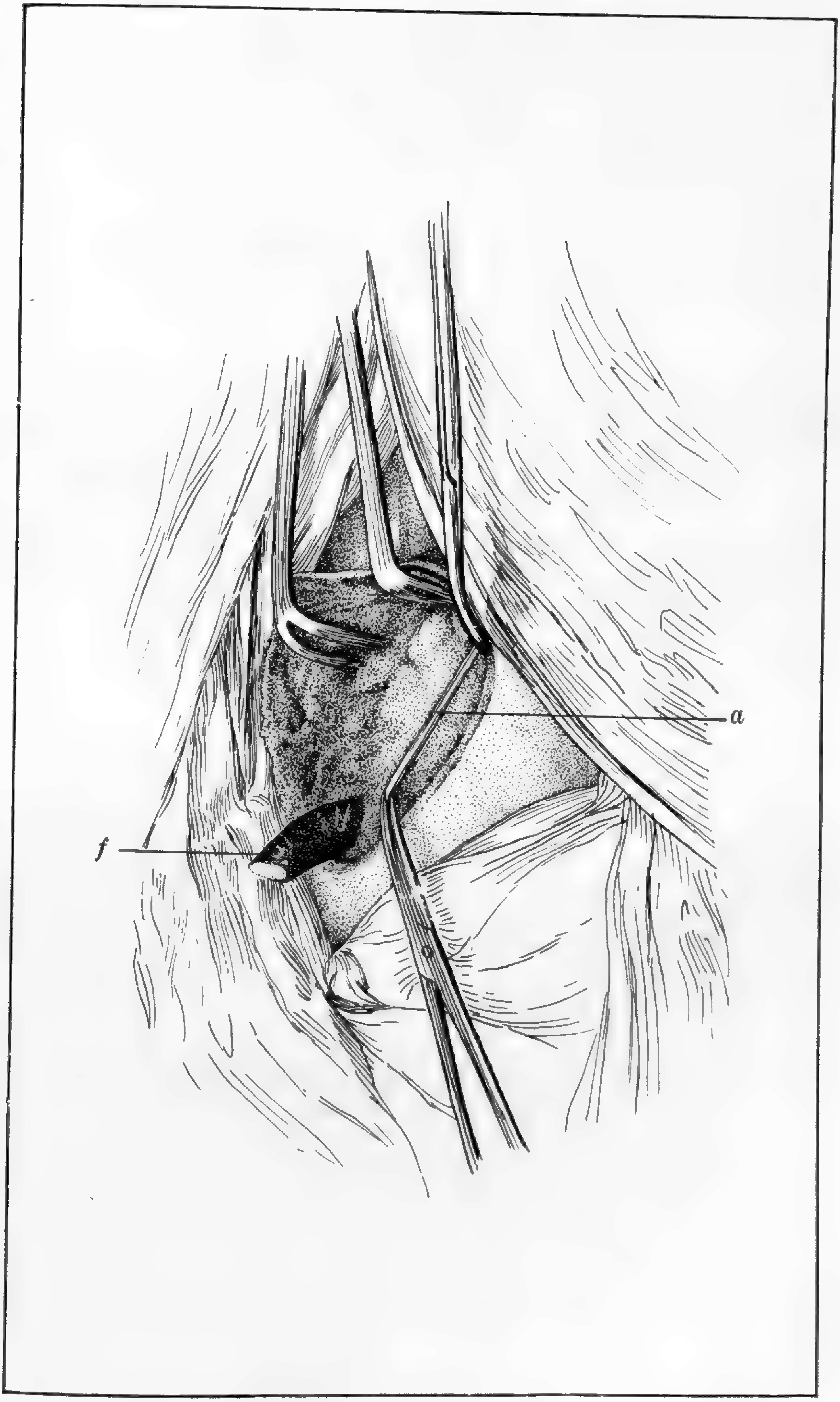


PLATE 4.

PLATE 5.

PLATE 6.

*d*[1]. Body usually with the posterior extremity cleft, anal opening at the anterior end of this cleft and covered by a pair of triangular plates; these characters more or less obscured in the species that are covered with wax. .............................. **Coccinæ.**

*d*[2]. Posterior extremity of body not cleft, sometimes more or less indented; without plates over anal opening; body usually covered with cottony or mealy secretion or inclosed in a sac, rarely naked .............................................................. **Dactylopiinæ.**

*a*[2]. Abdomen terminating in a compound segment or pygidium; legs wanting; body covered by a firm waxy scale readily separable from the insect and made up in part of larval exuviæ.......................... **Diaspinæ.**[5]

## MONOPHLEBINÆ

This subfamily is represented in the Philippines by species having the legs and antennæ well developed, the latter 8- to 11-segmented in the adult female, the body more or less covered dorsally with waxy, powdery, or cottony secretion, the anal ring dorsal and without setæ, the derm usually closely crowded with pores and hairs over practically the whole surface, and abdominal spiracles in all stages.

*Key to the Philippine genera of the Monophlebinæ.*

*a*[1]. With not more than three pairs of abdominal spiracles; body hairs slender, tapering; adult female usually secreting a distinct elongated posterior ovisac (one exception)............................................. **Icerya** Sign.

*a*[2]. With more than three pairs of abdominal spiracles; adult female with more or less waxy or mealy secretion, but without ovisac.

*b*[1]. Dorsal body hairs stout, not tapering, bluntly rounded at apices; with seven pairs of abdominal spiracles.................... **Lophococcus** Ckll.

*b*[2]. Dorsal body hairs slender, tapering, acute at apices; adult female naked or more or less covered with mealy secretion dorsally; with seven pairs of abdominal spiracles.............................. **Drosicha** Walker.

In this subfamily a number of males, without females, have been described from the Philippines. Unfortunately it has not been possible to connect more than a single one of these with already described females, and as they are given in Miss Robinson's paper no further mention is made of any but the one which has been placed in synonymy.

### Genus **ICERYA** Signoret

The usual, but superficial, distinguishing character of this genus is the development of a posterior ovisac in the adult fe-

[5] Not discussed in this paper.

male, but this is lacking in *Icerya jacobsoni* Green among those found in the Philippines. This species is evidently closely related to *Icerya* in its other characters, however, and, pending a revision of the genera of this subfamily, it is preferable to leave it here. In addition to the development of the ovisac, the Philippine species of the genus have 10- or 11-segmented antennæ in the adult female; three pairs of abdominal spiracles in all species except *I. purchasi,* which has two; and a more or less definite band of glands and hairs ventrally for secreting the ovisac.

*Key to the Philippine species of Icerya.*

$a^1$. Antennæ 10-segmented in adult female; without ovisac; with at least two types of gland pores, some, in clusters along the body margin, large, with trilocular centers and a projecting tongue.
**I. jacobsoni** Green.

$a^2$. Antennæ 11-segmented and ovisac developed in adult female; without gland pores with trilocular centers.

$b^1$. Derm gland pores of two types, one smaller, varying in size and arrangement, with solid center, the other much larger, ringlike, with large open center; marginal wax filaments of body not very long, dorsal secretion with numerous glassy threads through it.

$c^1$. With two pairs of abdominal spiracles; large open center gland pores along body margin only; body hairs numerous, conspicuously black; ovisac fluted .......... **I. purchasi** Mask.

$c^2$. With three pairs of abdominal spiracles; large open center gland pores present on both dorsum and margins of body; body hairs dark reddish, not conspicuously black; ovisac smooth.
**I. seychellarum** (Westw.).

$b^2$. Derm gland pores of different sizes, but none so large as in preceding species, all with solid centers; body with a number of long, twisted, lateral and caudal filaments .......... **I. aegyptiaca** (Dougl.).

**Icerya jacobsoni** Green.

*Icerya jacobsoni* Green, ROBINSON, Philip. Journ. Sci. § D 12 (1917) 2.

I have seen some of the material on which Miss Robinson based her record, and in addition have examined specimens collected at Los Baños, Laguna Province, on *Litsea glutinosa,* December 11, 1917 (*Banks 18353*) and at the same place on *Psidium guajava,* January, 1919 (*Baker 10098*). The specimens from Banks were as much as 9 millimeters long. The figure copied by Miss Robinson and the accompanying drawings of the structural details of the species should make it readily recognizable.

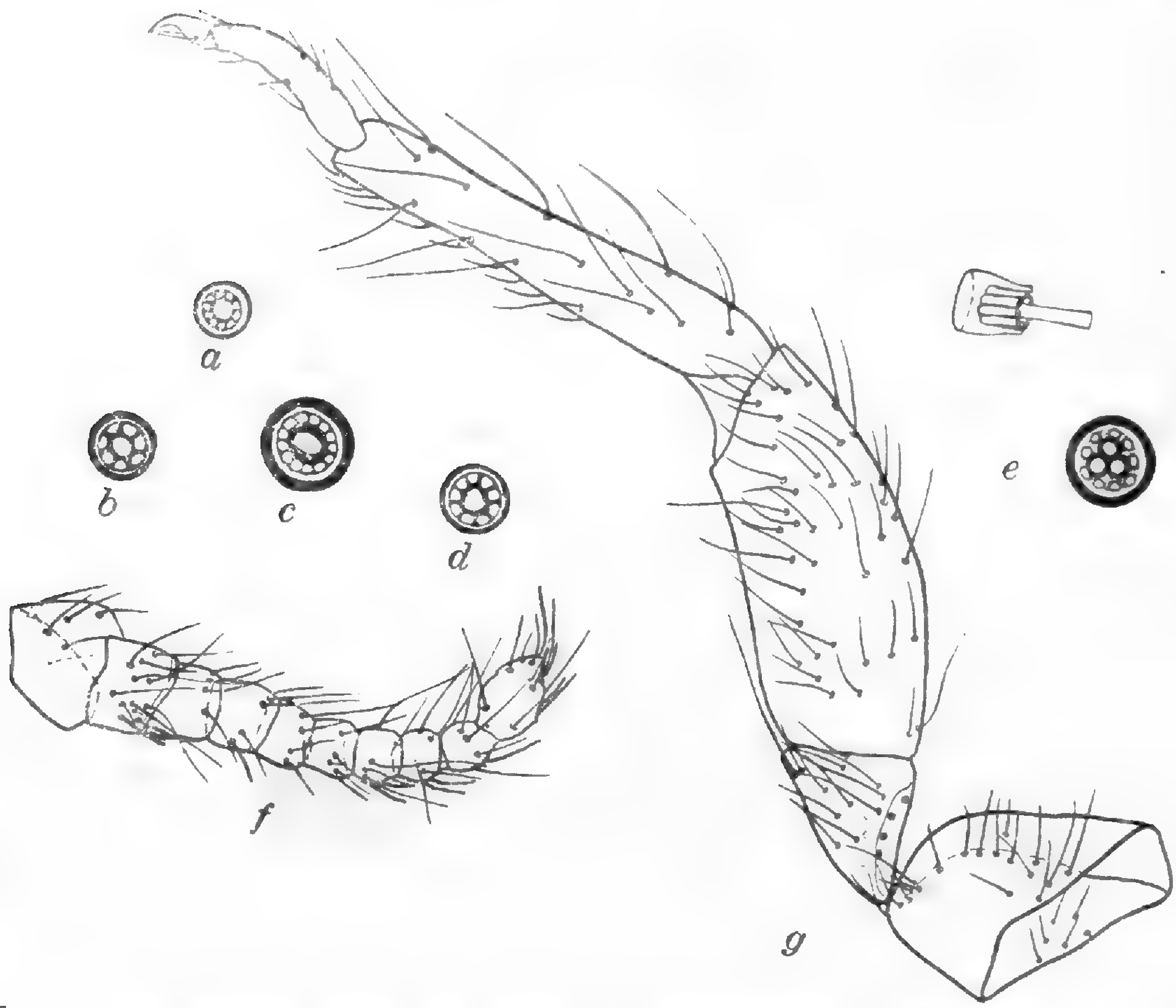


FIG. 1. *Icerya jacobsoni* Green, adult female; *a* to *d*, surface views of various sorts of circular wax gland pores found on body, × 640; *e*, surface view and section of trilocular center pores found in clusters along body margin, × 640; *f*, antenna, × 57.5; *g*, leg, × 57.5.

**Icerya purchasi Mask.**

*Icerya purchasi* MASKELL, Trans. New Zealand Inst. 11 (1878) 221.

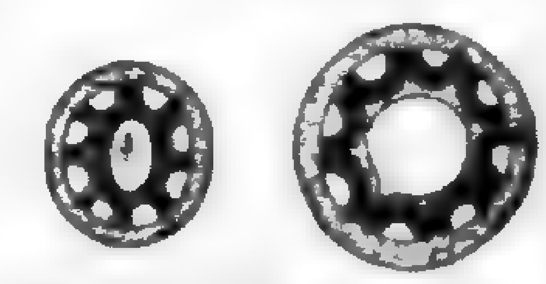

FIG. 2. *Icerya purchasi* Mask., adult female, showing two types of gland pores, × 640.

I was much surprised when a few specimens of this species were located in the midst of a mass of *Drosicha townsendi* (Ckll.), and it seems very strange that it has not been collected again in Manila, but the material at hand has produced no other specimens of this species. Those found were from Manila "on various trees" (coll. *Compere*), and were collected in 1911.

**Icerya seychellarum (Westw.).** Plate I, fig. 2.

*Icerya seychellarum* (Westwood), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 3.
*Icerya candida* COCKERELL, Proc. Dav. Acad. Sci. 10 (1905) 128.

A careful comparison of the type specimens of *Icerya candida* with a considerable amount of material of *I. seychellarum* fails to reveal any structural characters distinctive for the former species, while it will be observed from a comparison of the original description of *candida* with those of *seychellarum* that there are no differences given with the exception of a few very slight ones in relative lengths of antennal segments and the differences in the color of the secretion covering the insect. Other writers have already noted the variation in the secretionary color

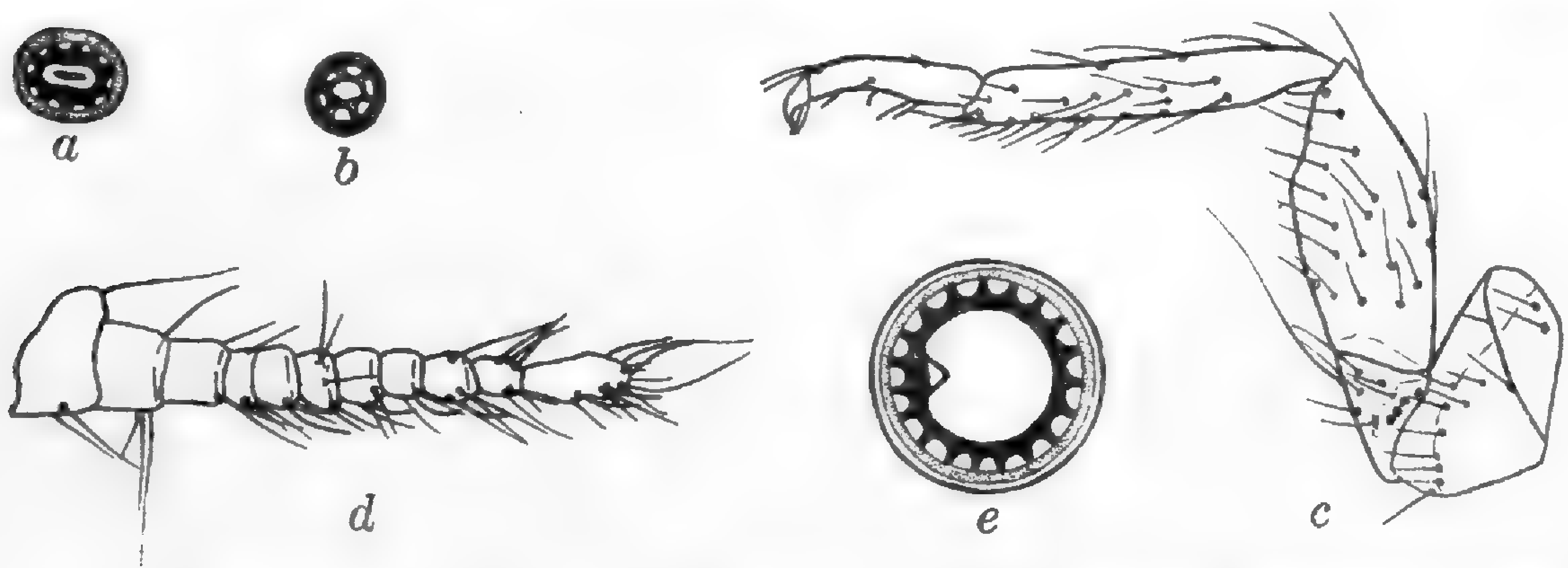


FIG. 3. *Icerya seychellarum* (Westw.), adult female; *a* and *b*, different sorts of solid-center gland pores on body, × 640; *c*, leg, × 57.5; *d*, antenna, × 57.5; *e*, large open-center gland pore, secreting glassy threads, × 640.

of *seychellarum*. The large gland pores with open centers and the presence of the numerous glassy threads in the secretion make this species easily recognizable.

In addition to the collection records given by Miss Robinson for the two species, the following may be cited:

LUZON, Manila, on *Artocarpus integrifolia* (coll. *P. J. Wester*), on *Citrus decumana* (coll. *B. Arce 2594*): Batangas Province, Tanauan, on *Citrus nobilis* (coll. *Wester*): Bulacan Province, Baliuag, on *Artocarpus integrifolia* (coll. *Arce 2614*): Quingua, on *Litsea glutinosa* (coll. *Arce 2616*): Laguna Province, Los Baños, on *Psidium guajava* (coll. *Banks 18453*), on *Streblus asper* (coll. *Baker 10093*).

**Icerya aegyptiaca** (Dougl.). Plate 1, fig. 1.

*Crossotosoma aegyptiacum* DOUGLAS, Ent. Month. Mag. 26 (1890) 79.
*Icerya aegyptiacum* (Dougl.), RILEY and HOWARD, Insect Life 3 (1890) 97.

This species does not appear to have been previously reported from the Philippine Islands, but the material sent by Mr. Mackie for determination gave the following records: Manila on *Barleria cristata* (coll. *Arce 2606*) and *Morus alba* (coll. *Arce 2568*). In addition it is known from Manila on *Citrus* (coll. *Compere*).

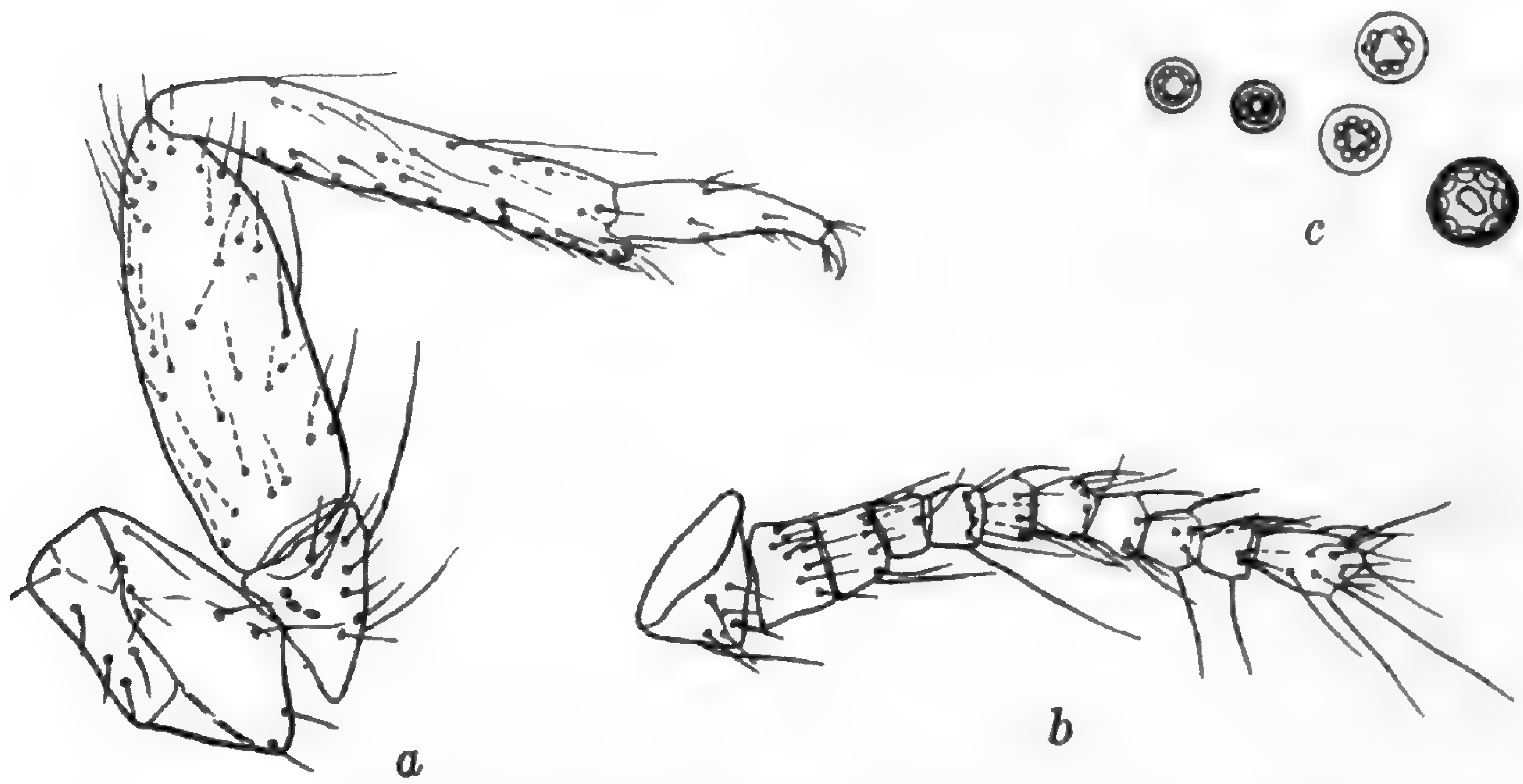


FIG. 4. *Icerya aegyptiaca* (Dougl.), adult female; *a*, leg, × 57.5; *b*, antenna, × 57.5; *c*, various sorts of gland pores present on body, × 640.

## Genus **LOPHOCOCCUS** Cockerell [6]

A comparison of the following apparently new species with specimens in the United States National collection of Coccidæ identified as *Lophococcus mirabilis* Ckll. shows that the two are apparently congeneric.

**Lophococcus convexus** sp. nov.

*Adult female.*—Presumably occurring on the branches of the host; maximum length, 12.5 millimeters; maximum width, 9; maximum height, 7; oval, strongly convex, anterior apex truncate, posterior rounded; sides of body nearly perpendicular for two-thirds of its total height, this area terminated above by distinct and rather prominent lateral ridges about three-fourths as long as total length of body; with a broad, rounded longitudinal ridge, more convex medially, along median line dorsally; ventrally flat or somewhat concave; color dark reddish brown; body in life evidently covered by more or less mealy or waxy secretion, apparently only by a rather thin, more or less uniform coat which is easily rubbed off of the more prominent portions of the body; this view is borne out by the absence of any specially differentiated groups of gland pores or hairs dorsally, but the exact condition in life is not determinable from the preserved material.

[6] I do not desire to undertake any discussion regarding the possible identity or priority of *Lophococcus* Ckll., *Aspidoproctus* Newst., and *Walkeriana* Sign., as there is not sufficient material available for study to determine this question finally.

*Body of female.*—Antennæ short and stout, 10-segmented, measurements of one as follows: I, 125 μ; II, 104 μ; III, 96 μ; IV, 57 μ; V, 53 μ; VI, 62 μ; VII, 75 μ; VIII, 64 μ; IX, 57 μ; X, 164 μ; widest at the basal segment and tapering gradually from base to apex; legs stout but not large, the parts of a middle leg with the following measurements: Trochanter, 293 μ; femur, 589 μ; tibia, 632 μ; tarsus, 339 μ; claw, 96 μ; submentum apparently 1-segmented; with two pairs of thoracic and seven pairs of abdominal spiracles, the thoracic much larger, flattened, the abdominal small, short-tubular, surmounted by a collar of disk gland pores, somewhat constricted at junction of pores and chitinous portion of spiracle, thoracic spiracles placed ventrally, the abdominal dorsally or subdorsally near body margin; anal opening small, circular, without setæ, placed dorsally some distance before poste-

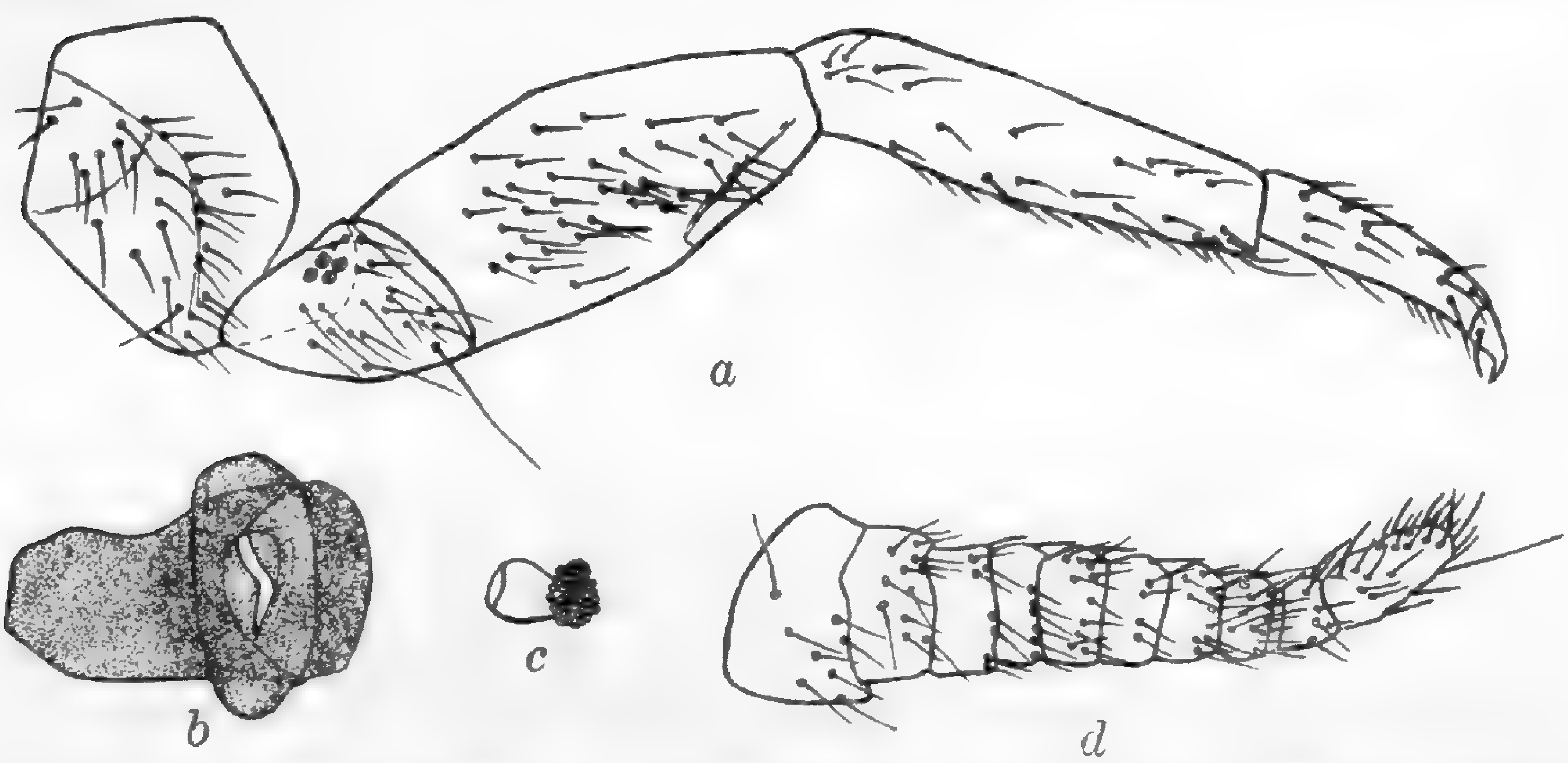


FIG. 5. *Lophococcus convexus* sp. nov., adult female; *a*, leg, × 57.5; *b*, thoracic spiracle, × 57.5; *c*, abdominal spiracle, × 57.5; *d*, antenna, × 57.5.

rior apex of body, joined by a short chitinized tube; genital opening placed ventrally near middle of abdomen and surrounded by a dense circular cluster of disk gland pores accompanied by some slender hairs; ventral cicatrices numerous, in groups of from one to five or more, arranged in six clusters curving forward from median posterior group on each side, making a total of thirteen groups; body dorsally and around the margin ventrally with a dense covering of stout, closely set, cylindrical hairs with bluntly rounded apices, among which are scattered disk gland pores with heavy walls, and occasionally a longer, slender, acute hair; ventrally with the area surrounding and posterior to the mouth parts bearing only numerous slender hairs and multilocular disk gland pores, a similar area present over venter of abdomen behind posterior legs, including cicatrices and genital opening, but with

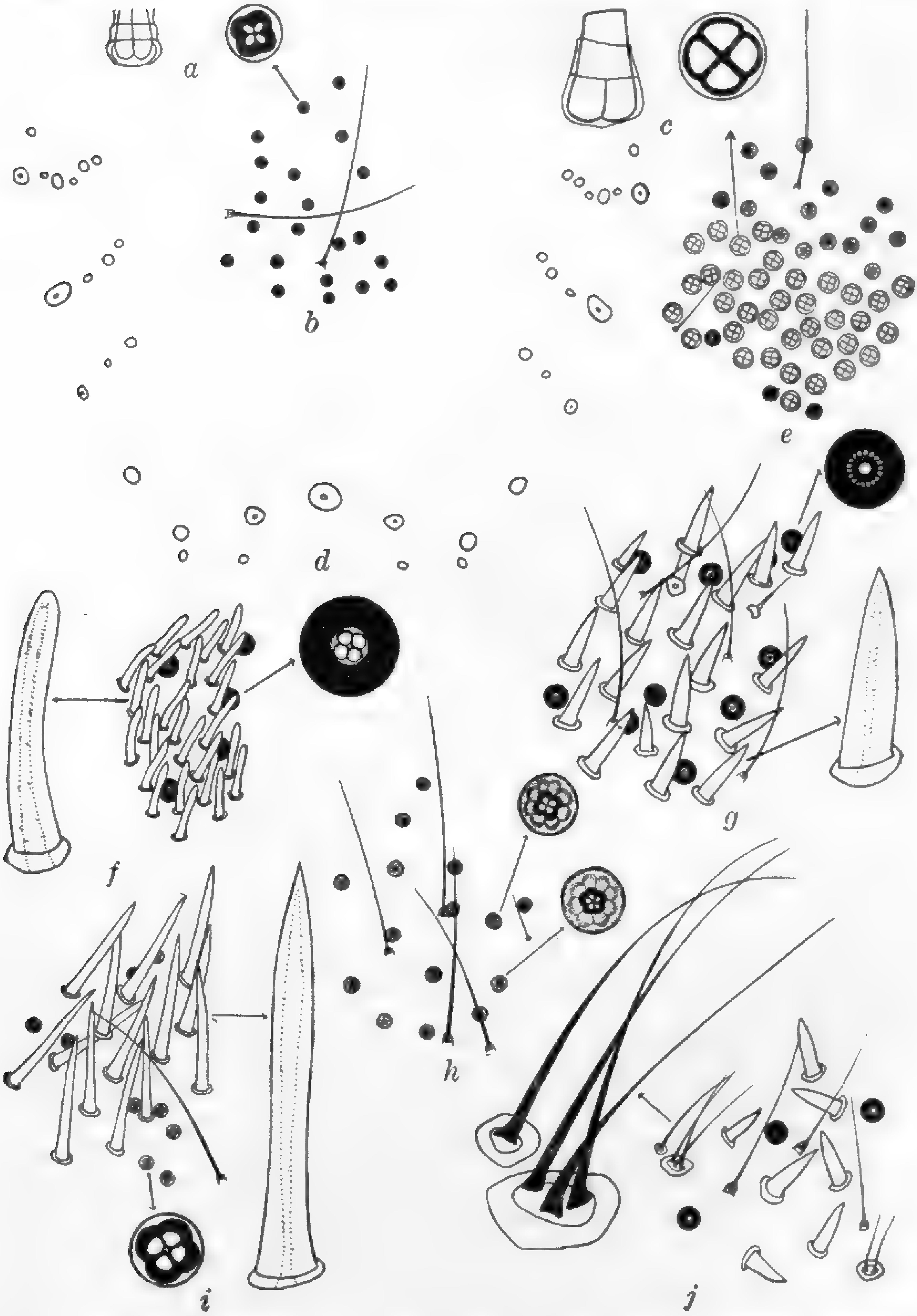


FIG. 6. *Lophococcus convexus* sp. nov., adult female, showing types of gland-pore and hair arrangements and ventral cicatrices; *a*, detail of quadrilocular pores placed ventrally posterior to beak, × 640; *b*, gross view of portion of same region, × 165; *c*, detail of glands from heavy band present ventrally in abdominal region, × 640; *d*, ventral cicatrices, showing large number and arrangement, × 30; *e*, portion of band mentioned under *c*, × 165; *f*, dorsal glands and spines, × 165, detail drawings, × 640; *g*, ventral submarginal spine, gland, and hair group, × 165, details of first two, × 640; *h*, glands and hairs occurring ventrally near genital opening, × 165, detail of gland, × 640; *i*, ventral spines, glands, and hairs near gland band mentioned under *c*, × 165, details of spine and gland, × 640; *j*, from same region as *g*, × 165, showing occasional development of more than one hair from a single base, with detail, × 640.

pores and hairs here arranged in fairly definite transverse rows instead of scattered as in the anterior area; this posterior area surrounded by a band of heavy gland pores, described later, and with large, stout, tapering, apparently hollow spines, which may sometimes be as much as 114 μ long, between these two areas and between them and the stout blunt spines of the dorsum and the margin of the venter, while interspersed among these sharp-pointed spines are long slender hairs, and occasional groups of two to four smaller slender hairs, all springing from a single heavily chitinized base; dorsal multilocular gland pores apparently of two types, some quadrilocular with the loculi circular, the others with an indeterminate number of smaller loculi arranged in a chain around a circular, oval, or somewhat triangular center, both of these types with very heavily chitinized borders; ventrally with about four somewhat different types of gland pores, around the mouth parts and behind them with small quadrilocular pores set in shallow cups, behind the posterior legs with a heavy circular band of quadrilocular pores set in deep cups and with large loculi, this circle surrounding the area in which the genital opening is placed; this area with transverse rows of disk pores with from three to six central loculi, the disk pores surrounding the genital opening placed in a large, closely crowded cluster, each with a single central nucleus and numerous indistinct loculi in a band around it; elsewhere on the ventral surface, particularly among the conical spines, with glands of the last type, but much more heavily chitinized and more distinct.

This species has been described from seven specimens mounted on slides and from a considerable number of unmounted specimens.

LUZON, Laguna Province, Mount Maquiling, on *Pithecolobium scutiferum,* July, 1918 (coll. *Baker*): Manila, on *Peltophorum ferrugineum,* 1911 (coll. *Compere 20186*). The types are in the United States National collection of Coccidæ.

While it is believed that the adult female has been characterized in the preceding description, there have been no larvæ or eggs found with any of the specimens. The Manila specimens are almost certainly immature, as none of them exceeds 9 millimeters in length. The presence of such a number and variety of ventral glands indicates the probability of the development of special secretions at the time of oviposition, and it may be found that when the female is fully mature she is even larger than the dimensions given in the description. Fully mature females, young larvæ, and males should certainly be looked for in the Philippines.

I have also seen specimens that are almost certainly this species from Java, where they were collected by Mr. P. van der Goot.

### Genus **DROSICHA** Walker

The genus as recognized in this paper is sufficiently characterized in the key to genera to be recognizable. It is in all probability synonymous with *Monophlebus* Burm. as the latter genus is understood by E. E. Green and some other writers. One species has been collected in the Philippines.

**Drosicha townsendi** (Ckll.). Plate 1, fig. 3.

*Monophlebulus townsendi* COCKERELL, Proc. Dav. Acad. Sci. 10 (1905) 127 (♀); ROBINSON, Philip. Journ. Sci. § D 12 (1917) 4.
*Drosicha lichenoides* COCKERELL, Journ. Econ. Ent. 6 (1913) 142 (♀); ROBINSON, Philip. Journ. Sci. § D 12 (1917) 4.
*Llaveia benguetensis* COCKERELL, Journ. Econ. Ent. 9 (1916) 235 (♂); ROBINSON, Philip. Journ. Sci. § D 12 (1917) 5.

I have been especially fortunate in having available for examination the type material of both of the females listed above. A study of *M. townsendi,* the type material of which consists of a single specimen, shows clearly that at least one, and in all probability two, of the terminal segments of both antennæ are broken off, thus giving the impression that they are 6-segmented. A careful comparison with the type material of *D. lichenoides* shows that these two are the same. Neither of these females, as described by Cockerell, seems to be fully mature nor as large as the species becomes, in spite of the fact that Cockerell describes the eggs in his original description of the latter species. There does seem, however, to be a wide range in size of the adult female at the time of oviposition, and this may account for the fact that most of the adult females examined by me were larger than Cockerell's specimens. Through the collections of Mr. Geo. Compere in Manila it has been possible to examine a large quantity of material of this species, and to determine the synonymy of the male included above by a comparison of the males collected with the females by Compere, with Cockerell's description of *Llaveia benguetensis.*

In addition to the records given by Miss Robinson under the three different names, I have examined a large number of specimens as follows:

LUZON, Manila, on unnamed plant host, 1909 (coll. *Compere 15057*), on various plants, 1911 (coll. *Compere 21038*), on *Enterolobium saman* (coll. *Banks 9943*), on *Cassia* (coll. *H. S. Smith*), on *Hibiscus* (coll. *Arce 2567*): Laguna Province, Los

Baños, on *Eugenia malaccensis* (coll. *J. de Leon,* under *Banks 18456*), on unnamed host (coll. *Banks 18457*), on *Ipomoea carica* (coll. *Banks 18454*): Rizal Province, Pasig, on *Gymnosporia spinosa* (coll. *McGregor 376–4*).

On account of the previous confusion with regard to this species, some additional descriptive notes may assist in facilitating its recognition. The female becomes quite large, as much as 16 millimeters long, and strongly convex when mature and

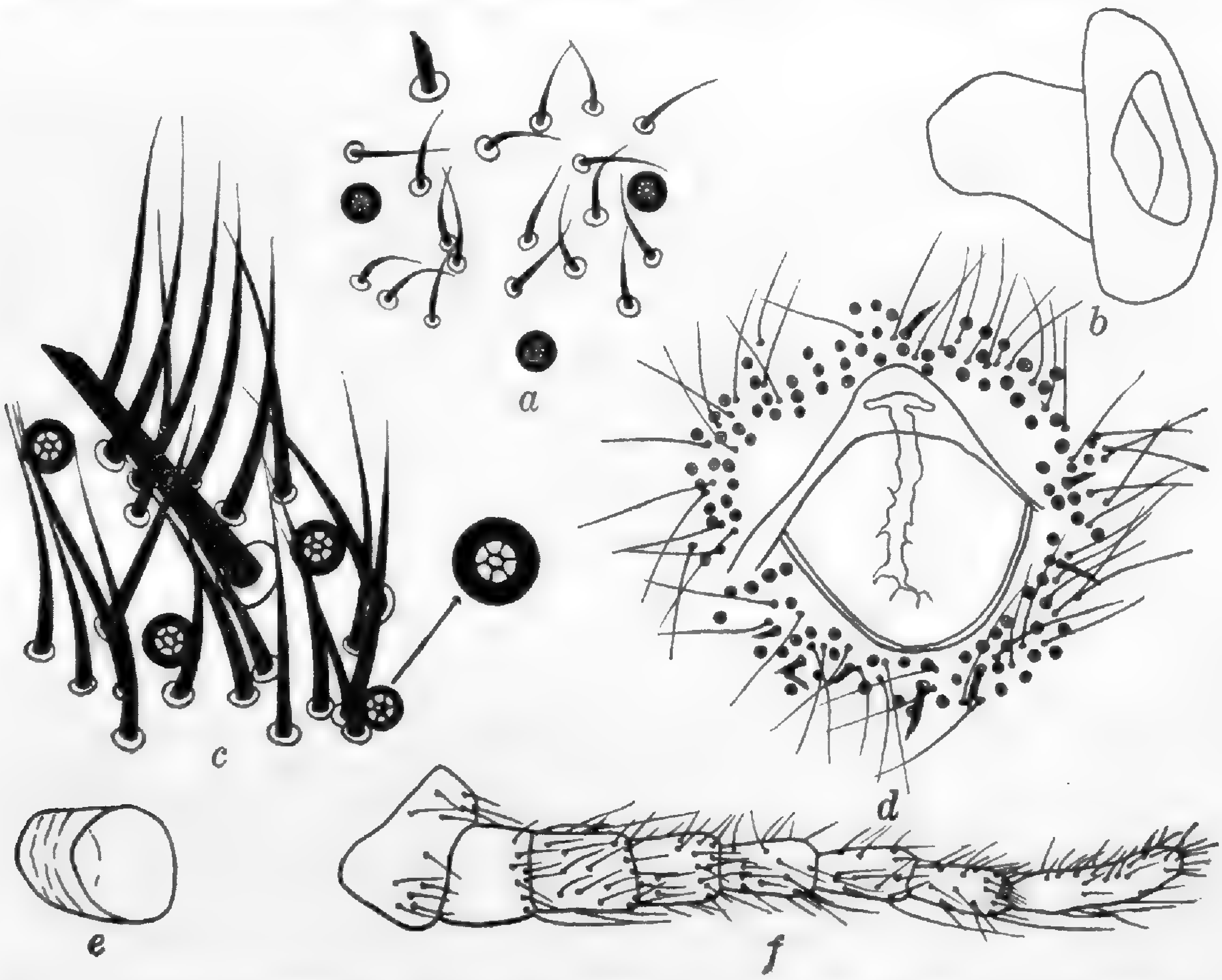


FIG. 7. *Drosicha townsendi* (Ckll.), adult female; *a*, hairs and glands from underside of body, × 335; *b*, thoracic spiracle, × 57.5; *c*, hairs and glands from dorsum near body margin, × 335, detail of gland, × 640; *d*, anal ring region, × 115; *e*, abdominal spiracle, × 335; *f*, antenna, × 57.5.

ready for oviposition. The anterior median notch seems to be constantly in evidence, although more conspicuous in the immature forms. At the time of oviposition, the female is much swollen, particularly behind the middle, and is concave as viewed from beneath, with the cavity well packed with cottony secretion. In the dried state, the female exhibits a considerable variety in size, shape, and coloring, and might easily be mistaken for more than a single species if isolated specimens had been collected. In spite of these apparent differences, the specimens examined seem to be identical structurally and there is sufficient variation in some of the large lots of material collected by Mr. Compere from a single colony to include most of the differences in appearance shown by individually collected specimens.

The whole derm of this species is closely crowded with fine hairs, with larger ones of varying lengths, and a single type of multilocular disk gland pore but, with the number of loculi varying, scattered among the finer hairs, with the exception that dorsally in the anal ring region and ventrally in the region of the genital opening the glands are far more numerous and more closely crowded than elsewhere and the hairs are also more numerous. There are more or less distinct clusters of much larger and longer blackish hairs around the body margin and also some longer hairs ventrally between the antennæ and around the mouth parts. There are seven pairs of abdominal spiracles. In spite of the fact that Cockerell described *D. lichenoides* as having 9-segmented antennæ, none of the specimens examined, including part of the type material of that species, shows more than eight. There are three large ventral cicatrices or clear spaces, posterior to the genital opening, but these are collapsed and so faintly outlined in all the specimens examined that their exact size and shape are not determinable.

The young larva is oval with numerous body hairs and glands, and marginal groups, each composed of two or three, very long blackish hairs. The antennæ are 5-segmented, with the third and fifth segments much longer than the others and about equal in length, and the fifth distinctly clavate. The seven pairs of abdominal spiracles are present, although minute.

## DACTYLOPIINÆ

This subfamily group is used here according to the classification in the Fernald Catalogue of the Coccidae of the World, although the collection of species placed here probably includes several subfamilies. The Philippine species of this group are united mostly by the characters given in the subfamily key. The legs and antennæ are present or wanting, or variously reduced; the body is naked, covered with secretion, or inclosed in a sac. The anal ring is located at the posterior apex of the body and bears setæ in all the known Philippine species.

### *Key to the Philippine genera of the Dactylopiinæ.*

$a^1$. Body inclosed in a complete horny test or sac; body margin with a row of 8-shaped gland pores; legs wanting; antennæ very much reduced, minute........................................ Asterolecanium Targ.

$a^2$. Body naked or covered with cottony or mealy secretion; without 8-shaped gland pores; legs and antennæ usually present.

$b^1$. Without dorsal ostioles; without cerarii; anal lobes prominently developed, with dorsal spines and ventral setæ; body with a marginal fringe of large stout spines; naked; with a fringe of white thread-like filaments........ **Rhizococcus** Sign.

$b^2$. With at least a posterior pair of dorsal ostioles or oval openings near the caudal apex of the body; usually with cerarii or groups of spines and glands along the body margin, but without a continuous marginal fringe of spines; anal lobes not or very poorly developed; body covered with cottony or mealy white secretion, rarely naked.

$c^1$. Legs and antennæ well developed; body depressed, oval, covered with white mealy secretion and with more or less developed and protruding lateral and caudal filaments; posterior apex of body not invaginated.

$d^1$. Body with small chitinized areas laterally and dorsally, each bearing a pair of large, conical spines....**Synacanthococcus** g. nov.

$d^2$. Body without large, stout, grouped spines on dorsum, though sometimes with slender spines scattered over the upper surface.

$e^1$. Margins of each body segment bearing large, more heavily chitinized areas with a number of stout truncate spines and triangular gland pores on each; antennæ 9-segmented.... **Puto** Sign.

$e^2$. Margins of each body segment with not more than four or five spines in a single group, these all slender, pointed at apex, and not placed on a conspicuously chitinized area.

$f^1$. Antennæ normally 9-segmented........ **Phenacoccus** Ckll.

$f^2$. Antennæ normally 8-segmented or less. **Pseudococcus** Westw.

$c^2$. Legs wanting; antennæ very rudimentary; body naked; globose, much wrinkled when dry, reddish brown; apex of body invaginated in the form of a small cylindrical tube with the anal ring at the inner end........ **Antonina** Sign.

## Genus ASTEROLECANIUM Targioni Tozzetti

The members of this genus are all of small size, and have the female and immature stages completely inclosed in a horny and, usually, more or less transparent test or sac which bears a marginal fringe of filaments, usually brightly colored in life. The legs are wanting, the antennæ very minute, and there is a row, sometimes more than a single pore deep, of 8-shaped gland pores around the body margin, while additional pores of this type are frequently found on the dorsum. At present only one species from the Philippines has been examined, although, considering the large number which have been reported from the leaves of bamboo from Ceylon, it is difficult to believe that there are no more species in these Islands.

**Asterolecanium bambusæ (Bdv.).**

*Chermes bambusae* BOISDUVAL, Insectologie Agricole 3 (1869) 261.
*Asterolecanium bambusæ* (Bdv.) GREEN, Cocc. Ceylon 4 (1909) 328.

This species is listed from three lots of material collected at Manila on bamboo (*Compere 20230* and unnumbered) and (*Banks 10213*). It is one of the largest species in the genus, somewhat convex, broad oval in shape, and with a pinkish marginal fringe, at least in life. There is a single row of 8-shaped pores completely surrounding the body along the margin, and a few of the same type, but somewhat larger, dorsally near the middle line of the body.

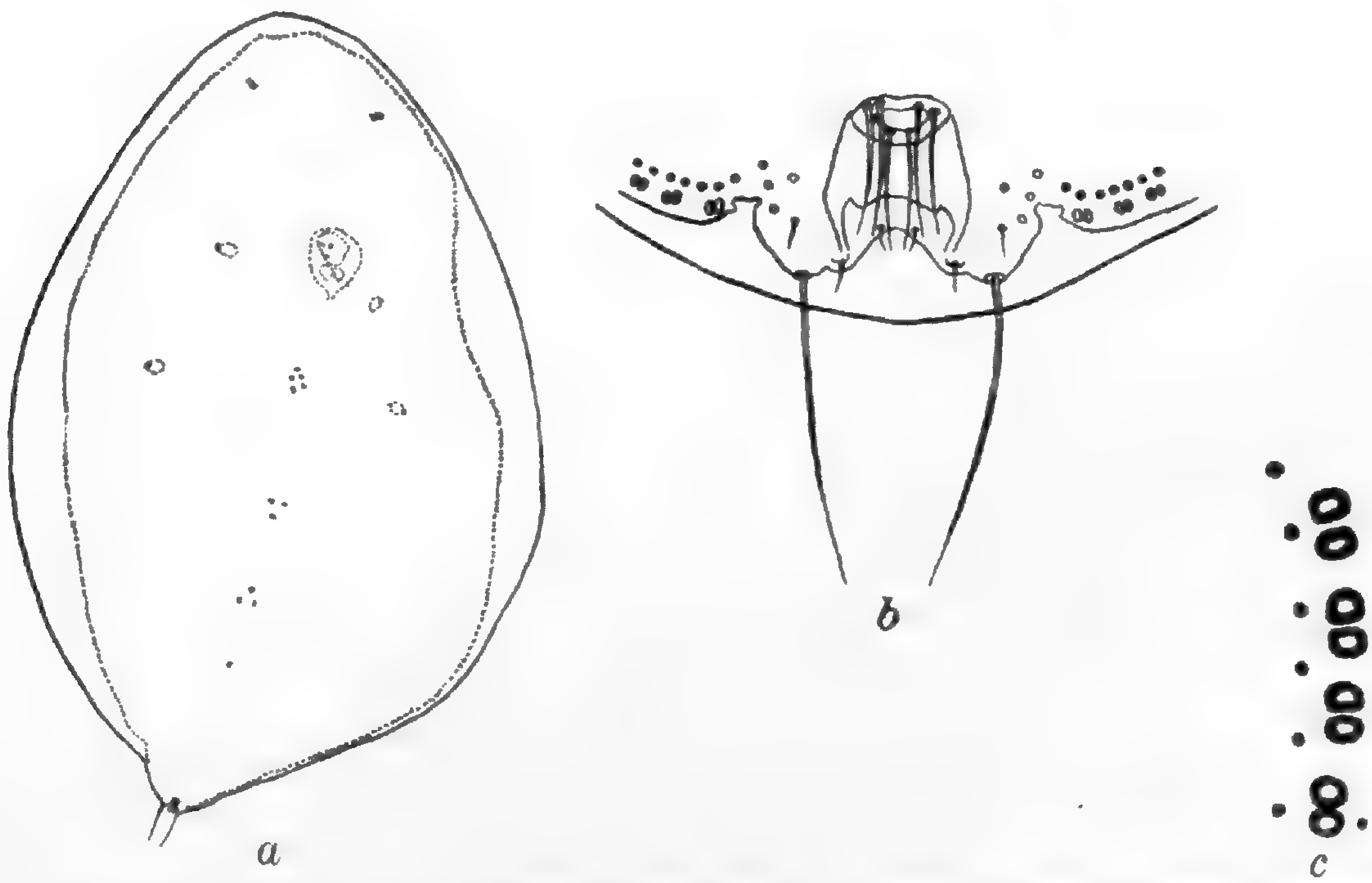


FIG. 8. *Asterolecanium bambusæ* (Bdv.), adult female; *a*, outline of body, showing marginal pores, dorsal pores, antennæ, spiracles, mouth parts, × 32; *b*, caudal apex of body, showing anal ring and lobes, × 325; *c*, detail of marginal double-pore band, × 640.

## Genus RHIZOCOCCUS Signoret

It is possible to include here a single, new species of this genus, through the kindness of Professor Cockerell in sending specimens which had been sent to him for determination.

**Rhizococcus philippinensis sp. nov.** Plate 1, fig. 5.

*Adult female.*—Occurring on the small twigs of the host, particularly in the crevices formed at points where branches are given off; broad oval, the abdomen narrowed, about 1.5 millimeters long and nearly as wide, convex medially, the margins more or less flattened, strongly wrinkled or ridged transversely on thorax and abdomen; reddish brown, mottled and spotted with lighter yellow; with a normally complete marginal fringe of short, white, cylindrical wax threads with tapering tips.

*Body of female.*—When mounted on a slide, oval; maximum length a little more than 1.5 millimeters, maximum width a little more than 1 millimeter; body and derm clearing completely when boiled in caustic potash; antennæ 6-segmented, III longer than the following segments combined, the measurements in microns as follows (measurements of I omitted):

| II | III | IV | V | VI |
|---|---|---|---|---|
| 36 | 82 | 21.5 | 18 | 36 |
| 32 | 82 | 17.5 | 16 | 32 |
| 36 | 82 | (a) | | |
| 32 | 68 | 14 | 15 | 32 |
| 28.5 | 71.5 | 15 | 18 | 36 |
| 32 | 78.5 | 18 | 18 | 32 |

[a] Broken.

Legs normal for the group, the lengths of the parts of a hind leg as follows: Coxa (maximum), 100 $\mu$; trochanter (maximum), 61 $\mu$; femur (maximum), 121 $\mu$; tibia (maximum), 89 $\mu$; tarsus (maximum), 125 $\mu$; claw, 25 $\mu$; tarsal digitule, 43 $\mu$; claw digitule, 30 $\mu$. Claws with a small denticle before the apex; apices of both pairs of digitules knobbed, knobs of tarsal digitules much larger, almost circular; hind coxæ with about twenty-five to twenty-eight small pores on basal half of each, hind tibiæ with about six to eight similar pores above near apex of each; anal lobes well developed and chitinized, rather long, outer sides nearly straight, inner curved, inner faces more or less roughened and tuberculate, total length about 100 to 107 $\mu$, apical hair at least 196 $\mu$ long, with three dorsal spines, the subapical near inner margin of lobe, stout at base, but with its apical half distinctly hairlike, inner and outer basal spines stouter, but with acute tips; with three hairs ventrally, the subapical one largest, the others close to the base, and the basal one smallest; with a large hair, about 115 $\mu$ long on each side between anal ring and anal lobe; anal ring surrounded by a chitinized band, united with the lobes and produced dorsally into a median chitinized cauda about 46 $\mu$ long and 57 $\mu$ wide, with a rounded and crenulate posterior margin; anal ring with six rather stout hairs, the longest noted about 107 $\mu$ long, the ring itself with a single row of large pores, accompanied by from one to three smaller pores on the inner side of the middle seta, on each half; with a continuous row of rather closely set, large, tapering spines, varying somewhat in length, all around the margin of body, this row supplemented by an interior median pair between the eyespots, largest spines noted about 50 μ long; dorsally without tapering

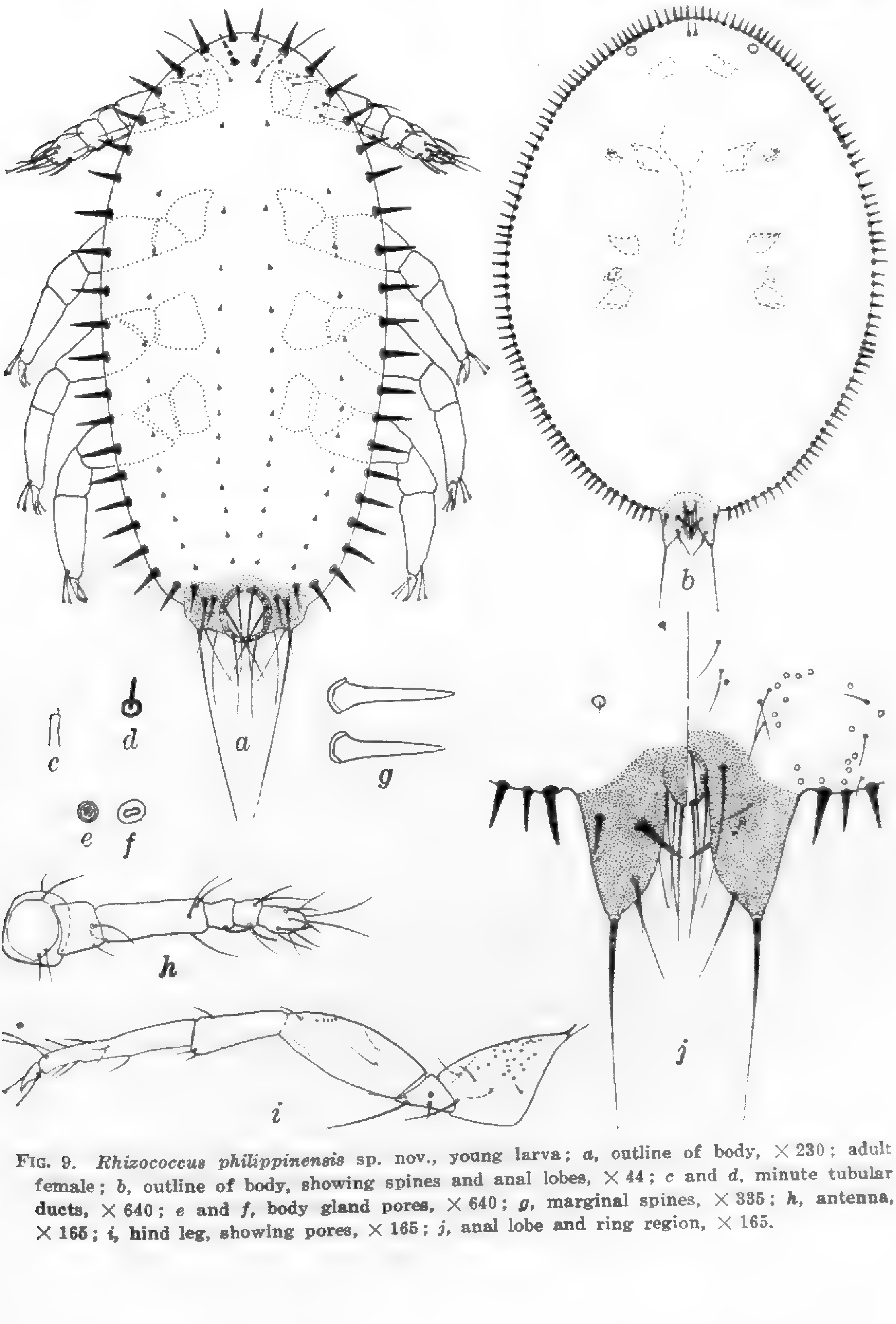


FIG. 9. *Rhizococcus philippinensis* sp. nov., young larva; *a*, outline of body, × 230; adult female; *b*, outline of body, showing spines and anal lobes, × 44; *c* and *d*, minute tubular ducts, × 640; *e* and *f*, body gland pores, × 640; *g*, marginal spines, × 335; *h*, antenna, × 165; *i*, hind leg, showing pores, × 165; *j*, anal lobe and ring region, × 165.

spines, with only a few minute cylindrical peglike spines set in circular bases, the spines about 7 $\mu$ long; ventrally, at least on abdomen, with transverse segmental rows of rather large hairs of varying length, the longest occurring near median line; dorsally, more particularly laterally, with fairly numerous minute tubular ducts, apparently with cup-shaped bottoms, although this has not been determined certainly; ventrally, particularly in the spiracular region and posteriorly, just before the anal ring, with fairly numerous, circular, multilocular disk gland pores, these all apparently quinquelocular.

*Young larva.*—Only embryonic larvæ inclosed in the body of the adult female have been available for examination, and consequently only a few structural details can be stated definitely. Antennæ 6-segmented, III only a little longer than any of the others; tarsal claw denticle only slightly developed, digitules about as in the adult; body with a marginal row of large spines and with four longitudinal rows of much smaller spines dorsally, at least on abdomen, these probably corresponding to the peglike spines of the adult; anal ring with six hairs, the cauda only slightly developed.

*Intermediate stage.*—A single specimen, apparently representing an intermediate stage of this species, shows only an intergradation of characters between the larva and adult, with one exception, this being the possession of a few large tubular ducts with cup-shaped bases, scattered dorsally, these apparently similar to those found in related genera and species, although it has not been possible to trace the usual slender continuation of the bottom, these occurring apparently in addition to the minute tubular type described in the adult.

This species has been described from four mounted specimens and a few more in position on the host, from Tibiao, Antique Province, Panay, on *Ficus* sp., May 9, 1918 (*McGregor*). The material was received through Professor Cockerell. The types are in the United States National collection of Coccidæ.

A rather hasty comparison of this species with specimens of other species in the collection at Washington indicates a fairly close relationship with *Rhizococcus intermedius* Mask., and, in morphological details, with *Eriococcus danthoniae* Mask. and *E. fagacicorticis* Mask.

The character of a majority of the descriptions of species in this genus is such that this species cannot be accurately compared with many of the species at present included here.

## Genus PUTO Signoret [7]

The presence of the numerous groups of glands and spines, encompassed by more or less definitely chitinized areas, along the body margin of the species of this genus makes it readily recognizable. In addition, in the Philippine species the antennæ are 9-segmented and the tarsal claws have a denticle. Only a single species has been reported from the Islands.

**Puto spinosus (Rob.).**

*Phenacoccus spinosus* ROBINSON, Philip. Journ. Sci. § D 13 (1918) 145.

I have had no opportunity to examine type material of this species, but the abundance of material received from the Philippines makes it seem impossible that any other species could be involved. The species is evidently very closely related to *Phe-*

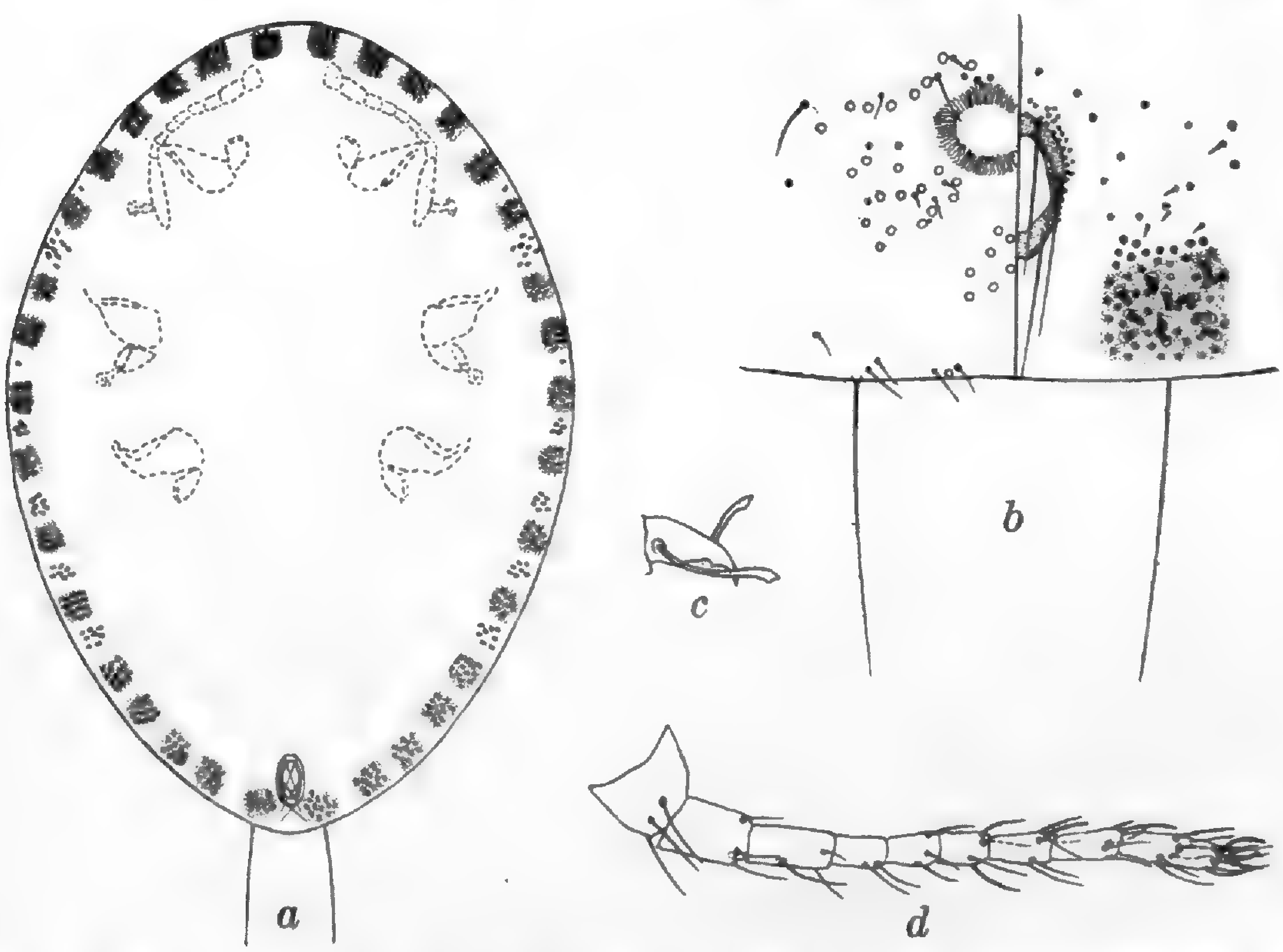


FIG. 10. *Puto spinosus* (Rob.), adult female; *a*, outline of body, showing principally the chitinized gland- and spine-bearing areas along the body margin, × 38; *b*, apex of abdomen, showing posterior chitinized area, anal and genital openings, and apical seta, × 110; *c*, claw, showing denticle, × 325; *d*, antenna, × 115.

[7] I have followed with no further study the conclusions reached by Ferris in regard to the synonymy of this genus and of *Ceroputo* Sulc, and have no opinion to express regarding this rearrangement. See G. F. Ferris, The California species of mealy bugs, Leland Stanford Junior University Publications, Univ. Ser. (1918) 61, 62.

*nacoccus mangiferae* Green, described from Ceylon, and Mr. Green, who has very kindly compared specimens with some of his material from Ceylon, states that it is identical with specimens which he has collected in Ceylon. In addition to the records given by Miss Robinson, I have examined specimens as follows:

LUZON, Manila, on "wild plants" (*Compere 20194*), "wild grass" (*Compere 20233*): Bulacan Province, Baliuag, on *Tabernaemontana* sp. (coll. *Arce 2619*); Katagpo, on *Antidesma leptocladum* (coll. *Arce 2609*); Quingua, on *Antidesma leptocladum* (coll. *Arce 2615*): Rizal Province, Balintauac, on *Mangifera indica* (coll. *Arce 2599*).

The accompanying figures and the characters given in the key should be sufficient to make this species recognizable.

### Genus **SYNACANTHOCOCCUS** novum

Antennæ, legs, and mouth parts normally developed, the first 9-segmented in the adult female; claw of legs with a denticle beneath before apex; body with pairs of large, stout, triangular spines on both dorsum and margin; dorsally with triangular gland pores, large short-tubular ducts, and large, flat, circular disk pores; ventrally with the large disk pores last mentioned, with quinquelocular disk pores, and with minute tubular ducts, with threadlike continuation of the bottom of each; otherwise characteristic of pseudococcine forms.

Type of genus, *Synacanthococcus bispinosus* sp. nov.

Judging from a study of such descriptions, figures, and specimens of related species as are available, this new genus is possibly more closely related to *Tylococcus* Newst. than to any other described genus. The presence of the dorsal spines in all stages, of the female at least, would indicate a position in the eriococcine group of genera for this genus, according to the older ideas of classification, but it is obviously a pseudococcine form.

**Synacanthococcus bispinosus** sp. nov.

*Adult female.*—All of the material studied preserved in liquid at one time, and external secretion therefore wanting; occurring on small twigs of the host; the denuded forms, after preservation in liquid and subsequent drying out, clay yellow in color; maximum length, mounted on a slide, a little more than 2 millimeters; maximum width, nearly 1 millimeter; elongate oval, broadest a little behind the middle; not giving off any appreciable color or stain when boiled in caustic potash; antennæ normally 9-segmented, the joint between the last two segments only slightly constricted, the measurements of the segments in microns as follows (segment I omitted):

| II | III | IV | V | VI | VII | VIII | IX |
|---|---|---|---|---|---|---|---|
| 46.5 | 28.5 | 23 | 28.5 | 24 | 28 | 28 | 46.5 |
| 40 | 32 | 25 | 32 | 25.5 | 32 | 25.5 | 46.5 |
| 46.5 | 28.5 | ([a]) | | | | | |
| 50 | 32 | ([a]) | | | | | |
| 50 | 32 | 26.5 | 35 | 26.5 | 32 | 25 | 50 |
| 47 | 35.5 | 26.5 | 35.5 | 35.5 | 32 | 28.5 | 52 |

[a] Broken.

Legs rather small, normal, the lengths of a middle leg as follows: Coxa, 64 $\mu$; trochanter (maximum), 68 $\mu$; femur (maximum), 161 $\mu$; tibia (maximum), 164 $\mu$; tarsus, 75 $\mu$; claw, 25 $\mu$; tarsal digitules, 39 $\mu$; claw digitules, 21 $\mu$. All digitules slender, slightly knobbed at apex, claw with a distinct denticle before the apex; only the posterior pair of dorsal ostioles noted; without marginal cerarii or groups of glands, pores, spines, and hairs on the body segments, these structures being replaced by pairs of stout conical spines, each set on a small, roughly circular, chitinized area, each of these chitinized areas also normally bearing a single triangular pore immediately inside and between the two spine bases, two minute clear circles on the same side and a single similar circle on the outer side; with sixteen or seventeen pairs of these along the body margin, all with two spines, except the second on each side from the anterior body apex, which usually has one; in addition with a row of nine similar spine clusters down the mid-dorsal body line, of which the anterior two have the individual spines separated by more than their own length and have an unchitinized space between them; with the last median pair on the sixth abdominal segment, and the next to the last on the third segment, these median pairs with the spines arranged transversely, and normally with two triangular gland pores, one on each side in the triangle between the spine bases; where the spines are separated, with one pore joined to each spine; with most of these pairs of large spines only slightly unequal in size, but with those on the anal lobes distinctly unequal, one about 21 $\mu$ long and 11 $\mu$ wide at base, the other about 25 $\mu$ long and only 7 $\mu$ wide at base, the spines in the median groups about equal; anal lobes not prominent, with an apical hair about 78 $\mu$ long, from which a ventral chitinized thickening, tapering anteriorly, extends forward; body with several types of gland tubes and pores: dorsally with some relatively very large, short-

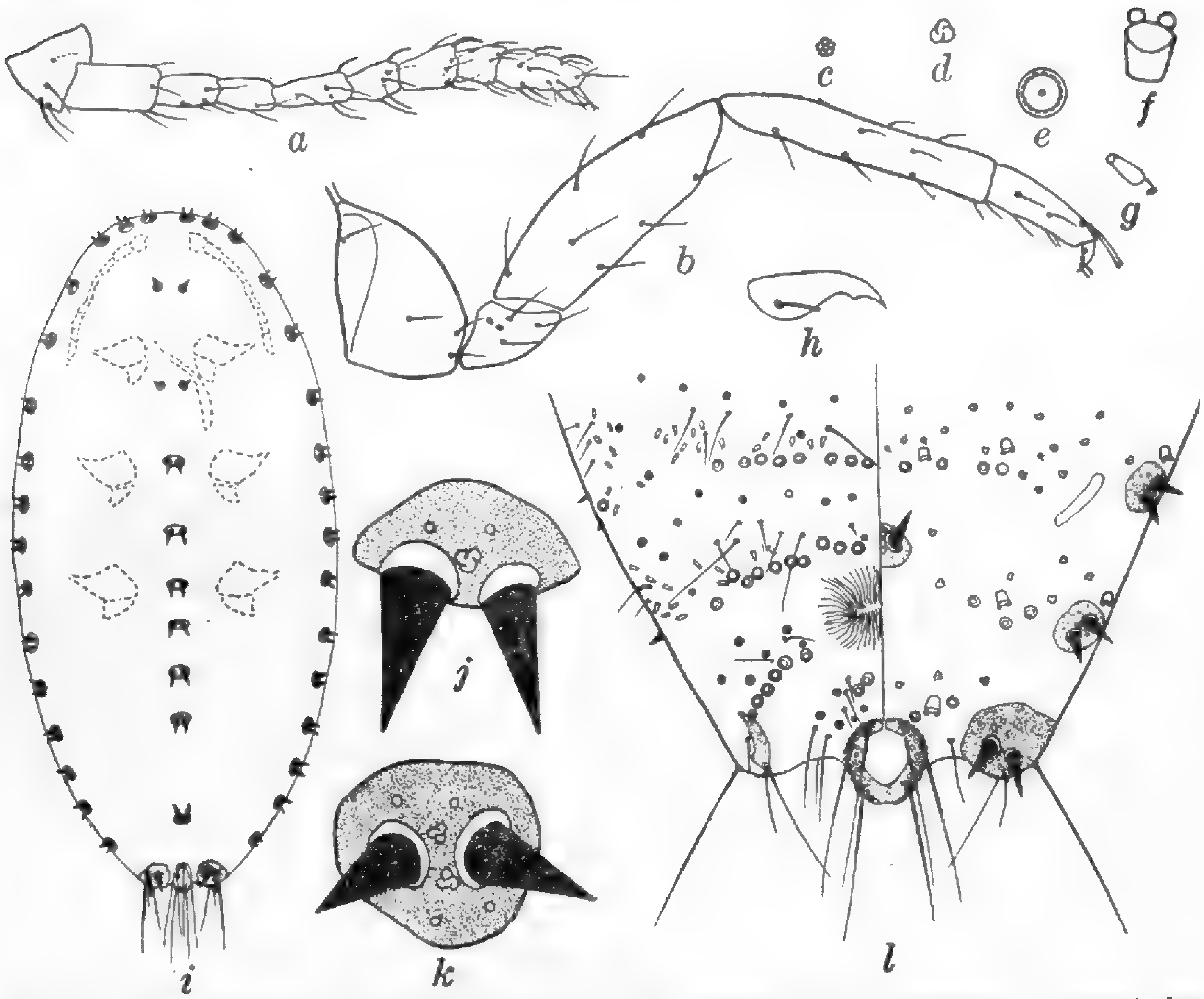


FIG. 11. *Synacanthococcus bispinosus* g. et sp. nov., adult female; *a*, antenna, × 165; *b*, leg, × 165; *c* to *g*, five different types of gland pores found on body, × 640; *h*, tarsal claw, × 640; *i*, outline of body, showing arrangement of spine groups, × 45; *j*, lateral abdominal spine group, × 640; *k*, median abdominal spine group, × 640; *l*, apex of abdomen, × 165.

tubular ducts with two or three minute circles attached to their outer margins, these two on the anal lobe segment, four with one pair marginal on the next segment anteriorly, six with one pair marginal on the next, and eight with one pair marginal on the remaining abdominal segments, these gland tubes also present, but in fewer numbers and uncertain arrangement, on head and thorax; next in size, with somewhat smaller, flat, circular disk glands with minute central pore and crenulations, possibly representing openings, near the outer margin, normally with four of these on the anal lobe segment, eight on the next anterior, and an increasing number on the anterior abdominal segments, and in the thoracic and head region, these usually more or less grouped in connection with the larger glands previously described; finally with a much larger number of the ordinary triangular and trilocular gland pores scattered over the whole dorsum and margin; ventrally with large disk glands already described for the dorsum but much more numerous, in transverse segmental rows, with tiny tubular glands with a minute threadlike continuation of the bottom of each, also quite numerous, and with numerous quinquelocular disk pores, all of these obviously arranged in transverse rows according to the segmental divisions; thus with five different types of gland pores in this species; dorsally in addition to the large spines already described, with transverse segmental rows of minute conical spines; without spines ventrally, but with transverse segmental rows of relatively long slender hairs, these varying greatly in length among themselves; anal ring small, nearly circular, with six setæ, the longest about 90 $\mu$ long, and with two rows of pores on each half.

*Young larva.*—No satisfactory mounts of this stage obtained, but apparently with the paired spines of the adult present and in much the same arrangement, and with some, at least, of the same gland pore types present.

The species has been described from six adults and four larvæ mounted on slides, and from a small additional amount of material originally preserved in liquid but now dried out. The specimens are all from Manila, some from *Ficus* (*20158*), some from "wild plant" (*20176*), and some from wild fig (without number), all collected by Geo. Compere, exact date of collection not stated. The types are in the United States National collection of Coccidæ.

The presumed relationships of this genus and species have been indicated in the previous discussion of the genus. So far as my acquaintance with this group of coccids extends, it is rather unusual to find five different types of secreting gland pores in a single species.

### Genus **PHENACOCCUS** Cockerell

This genus as limited here is characterized only by the occurrence of 9-segmented antennæ in the adult female. The cerarii of the single species included from the Philippines are poorly developed, in contrast to the usual condition in *Pseudococcus* and in the two preceding genera.

**Phenacoccus hirsutus** Green.

*Phenacoccus hirsutus* GREEN, Mem. Dept. Agr. Ind. 2[3] (1908) 25.

This species may be separated from the other known Philippine members of the group by the characters given in the generic key. Whether it will remain in the genus *Phenacoccus* when any generic revision of this subfamily is undertaken is very doubtful. There is no tooth on the tarsal claw, and there are only about six distinguishable pairs of cerarian spines on the abdomen, on each side, the anterior pairs apparently becoming modified into large hairs or setæ, and the joint separating the eighth and ninth antennal segments is not so distinctly constricted as in other species of the genus. Each anal lobe bears a stout hair at least twice as long as the anal ring hairs. There appear to be four different types of glands present, large tubular, small tubular, large disk, and medium triangular, all of which are quite abundant, although not in the same numerical quan-

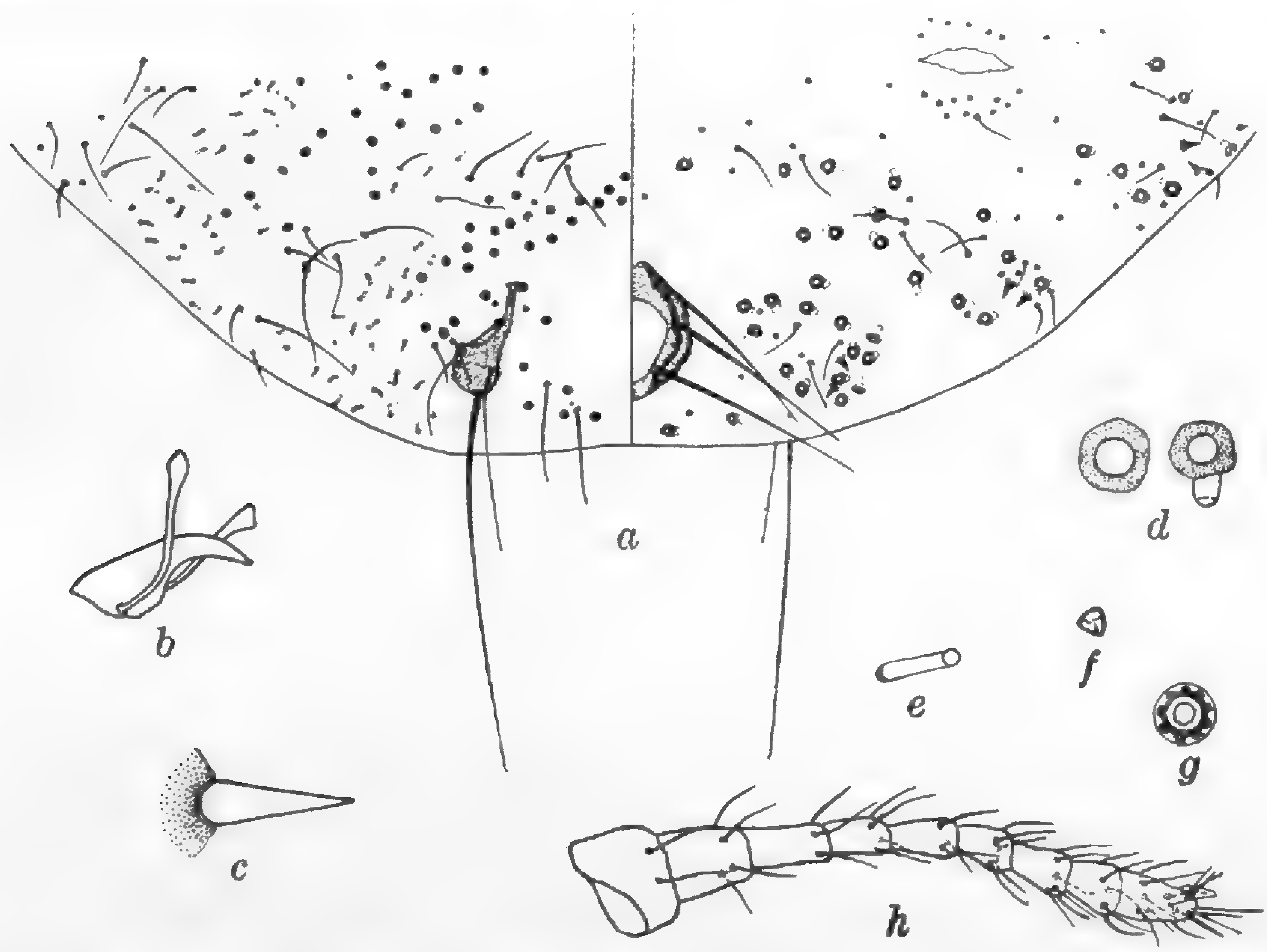


FIG. 12. *Phenacoccus hirsutus* Green, adult female; *a*, posterior apex of body, showing cerarii, glands, anal ring, apical setæ, and ventral chitinized area, × 115; *b*, tarsal claw, × 440; *c*, cerarian spine, × 640; *d* to *g*, four different types of gland pores found on body, × 640; *h*, antenna, × 115.

tity. The species as found in the Philippines occurs in abundance on the small twigs and leaves of its hosts, often in masses, and appears to form a matted sac, although the poor condition of all of the material studied prevents an accurate statement regarding the external appearance. I have examined specimens from the following lots of material:

LUZON, Manila, on *Hibiscus* (coll. *Compere 20172*): Bulacan Province, Baliuag, on *Samanea saman* (coll. *Arce 2608*): Rizal Province, Alabang, on *Hibiscus* (coll. *B. Duckworth 2566*).

## Genus PSEUDOCOCCUS Westwood

This genus as used here includes some species which would need to be distributed to other genera in any revision of the group, but is substantially as it is constituted in the Fernald Catalogue. It is characterized chiefly by having the antennæ normally 8-segmented or less, by the absence of a claw on the denticle, and by the usually well-developed cerarii. I have examined specimens of five species from the Philippines.

*Key to the Philippine species of Pseudococcus.*

$a^1$. Margin of body segments dorsally with a varying number of large, tubular glands, and with a dorsal median pair on most of the segments, each of these opening into a heavily chitinized plate bearing several hairs, these glands most numerous on the caudal abdominal segments and near the antennæ; with only an apical pair of cerarii; secretionary covering of female with glassy threads in it. P. virgatus (Ckll.).

$a^2$. Without such prominent tubular glands, but often with smaller inconspicuous tubular glands present; cerarii more numerous in most species.

$b^1$. With the three or four abdominal segments anterior to the anal ring with a long slender seta on each margin, all of these approaching in length those found on the anal lobe segment; body large, plump, legs and antennæ short and stout; cerarii wanting except on the posterior abdominal segments. ............... P. sacchari (Ckll.).

$b^2$. With such large setæ only on the anal lobes.

$c^1$. With dorsal lanceolate spines; cerarii poorly developed, the spines lanceolate, and those anterior to the last four or five pairs widely separated and without grouped trilocular pores; antennæ normally 7-segmented, short and stout, as are the legs; female very plump, inclosed in a more or less distinct white secreted sac. P. filamentosus (Ckll.).

$c^2$. Without dorsal spines, although sometimes with rather stout hairs; cerarii all well developed, the conical spines surrounded by a varying number of trilocular gland pores; antennæ normally 8-segmented; female not inclosed in a sac.

$d^1$. Ventral chitinized area on anal lobes irregularly quadrate; anal lobe hair only a little longer than anal ring hair; the penultimate or antepenultimate, and some of the anterior cerarii usually with three or even more spines in each cerarius. P. bromeliae (Bouché).

$d^2$. Ventral chitinized area on anal lobes linear; anal lobe hair about twice as long as anal ring hair; abdominal segments with only two spines in each cerarius................................ P. lilacinus Ckll.

**Pseudococcus virgatus** (Ckll.). Plate 1, fig. 7.

*Pseudococcus virgatus* (Cockerell), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 6.

*Pseudococcus virgatus* (Cockerell), variety, Proc. Dav. Acad. Sci. 10 (1905) 130; ROBINSON, Philip. Journ. Sci. § D 12 (1917) 7.

A careful examination of the type material of *P. virgatus*, variety, fails to show any characters that would definitely distinguish the so-called variety from the species, and the suggestion

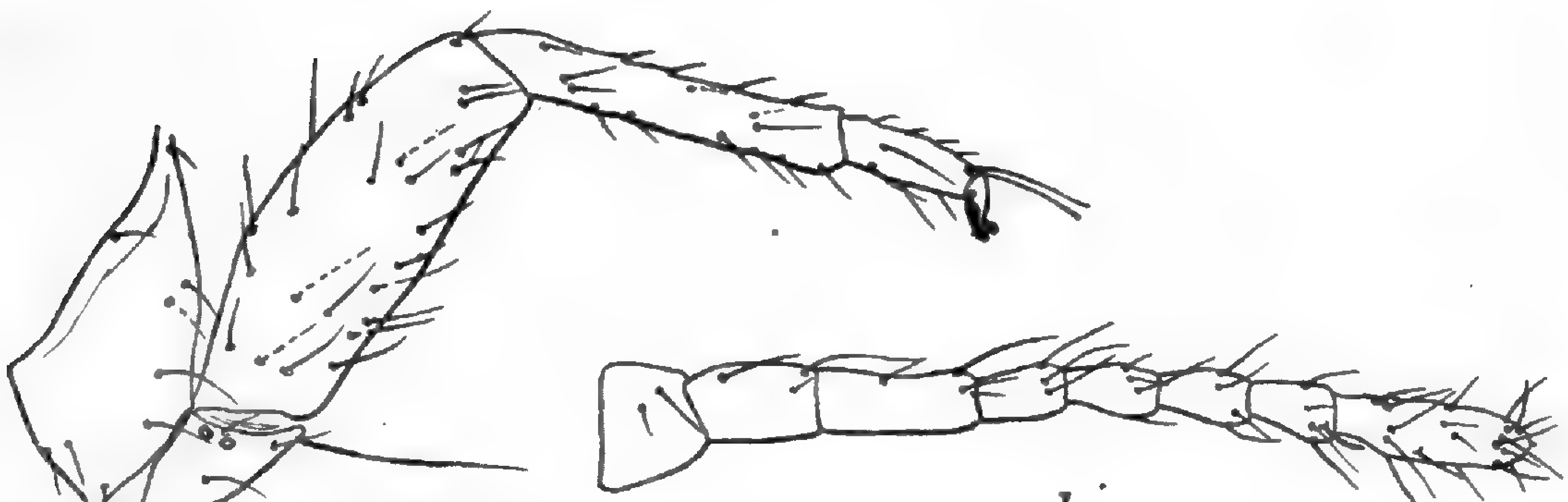


FIG. 13. *Pseudococcus virgatus* (Ckll.), adult female; *a*, leg, × 115; *b*, antenna, × 115.

of Brain[8] that the variety is not to be considered as distinct from typical *virgatus* seems to be entirely correct. The unreliability of the antennal formula and of the relative lengths of antennal segments as a specific characteristic has been proven so frequently that it hardly seems worth while to call attention to it again.

Specimens of this species from the following lots of material have been examined:

LUZON, Manila, on *Pithecolobium dulce, Achyrantes aspera, Amaranthus spinosus,* and *Acalypha wilkesiana* (coll. *Mc-*

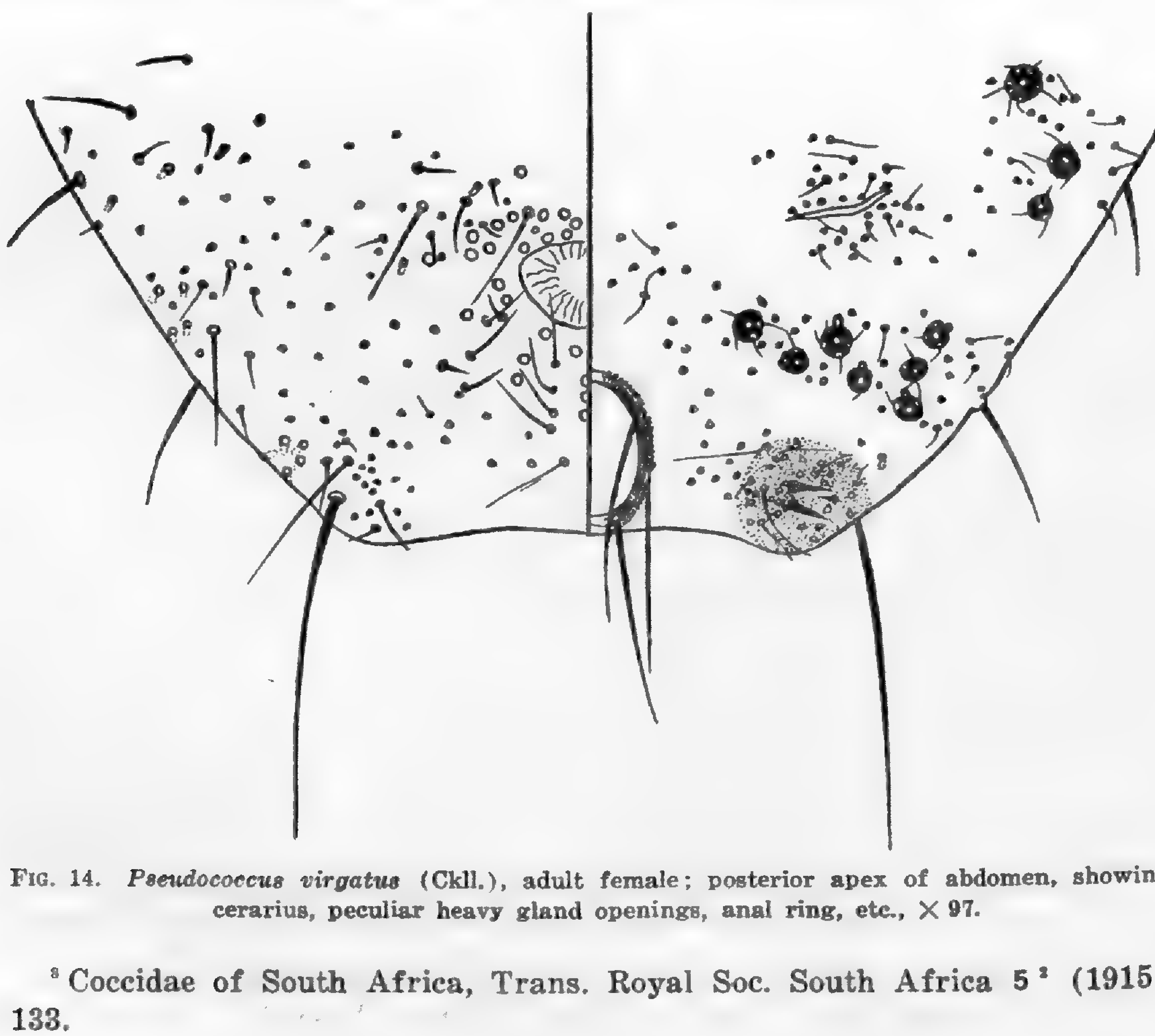


FIG. 14. *Pseudococcus virgatus* (Ckll.), adult female; posterior apex of abdomen, showing cerarius, peculiar heavy gland openings, anal ring, etc., × 97.

[8] Coccidae of South Africa, Trans. Royal Soc. South Africa 5[2] (1915) 133.

*Gregor*), on cowpea (coll. *Arce 2588*), on *Lycopersicum esculentum* (coll. *Arce 2586, 2587*): Bulacan Province, on guava (*McGregor*): Laguna Province, Los Baños, on *Ricinus communis* (coll. *Banks 18461*), on *Mimosa pudica* (coll. *Banks 18460*), on *Xanthosoma sagittifolium* (Coccidæ Malayana, *9*, coll. *Baker*); Paete, on *Cyathula prostrata* (coll. *McGregor*): Rizal Province, Fort William McKinley, on *Leucaena glauca* (coll. *McGregor*); Las Piñas, on *Wrightia laniti* (coll. *McGregor*); Pasay, on *Annona squamosa, Gliricidia sepium, Antigonon leptopus,* and *Jatropha curcas* (coll. *McGregor*); San Pedro Makati on *Pithecolobium dulce* and *Lantana camara* (coll. *McGregor*). Also from the Philippines on "Marang" [=*Artocarpus odoratissima*], collected at plant quarantine, Washington, D. C., by H. L. Sanford (F. H. B. *1320*).

**Pseudococcus sacchari** (Ckll.).

*Dactylopius sacchari* COCKERELL, Journ. Trin. Field Nat. Club 2 (1895) 195.

*Pseudococcus sacchari* (Ckll.), FERNALD, Cat. Cocc. World (1903) 109.

This species is represented by two lots of material, both collected at Manila by Geo. Compere, one on sugar cane (*20165*), the other on bamboo grass (*20229*).

**Pseudococcus filamentosus** (Ckll.). Plate 1, fig. 8.

*Pseudococcus filamentosus* (Ckll.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 8.

The following records, in addition to those given by Miss Robinson, may be listed for this species:

LUZON, Manila, on *Tamarindus indicus* (*2589*), *Annona reticulata* (*2570*) (coll. *Arce*); "wild bush" (*20170*), citrus (no number), and unnamed host (*20232*) (coll. *Compere*): Bataan Province, Lamao, on orange (coll. *Wester*). The illustrations and key characters should make its separation from other Philippine species comparatively easy.

**Pseudococcus bromeliae** (Bouché).

*Lecanium bromeliae* BOUCHÉ, Schädl. Gart. Ins. (1833) 49.

*Pseudococcus bromeliae* (Bouché) FERNALD, Cat. Cocc. World (1903) 98.

What is unquestionably this species, as it is identified to-day, and as determined by a comparison with numerous specimens from pineapple from all over the world, was included in the material received for identification from Mr. Mackie. According to

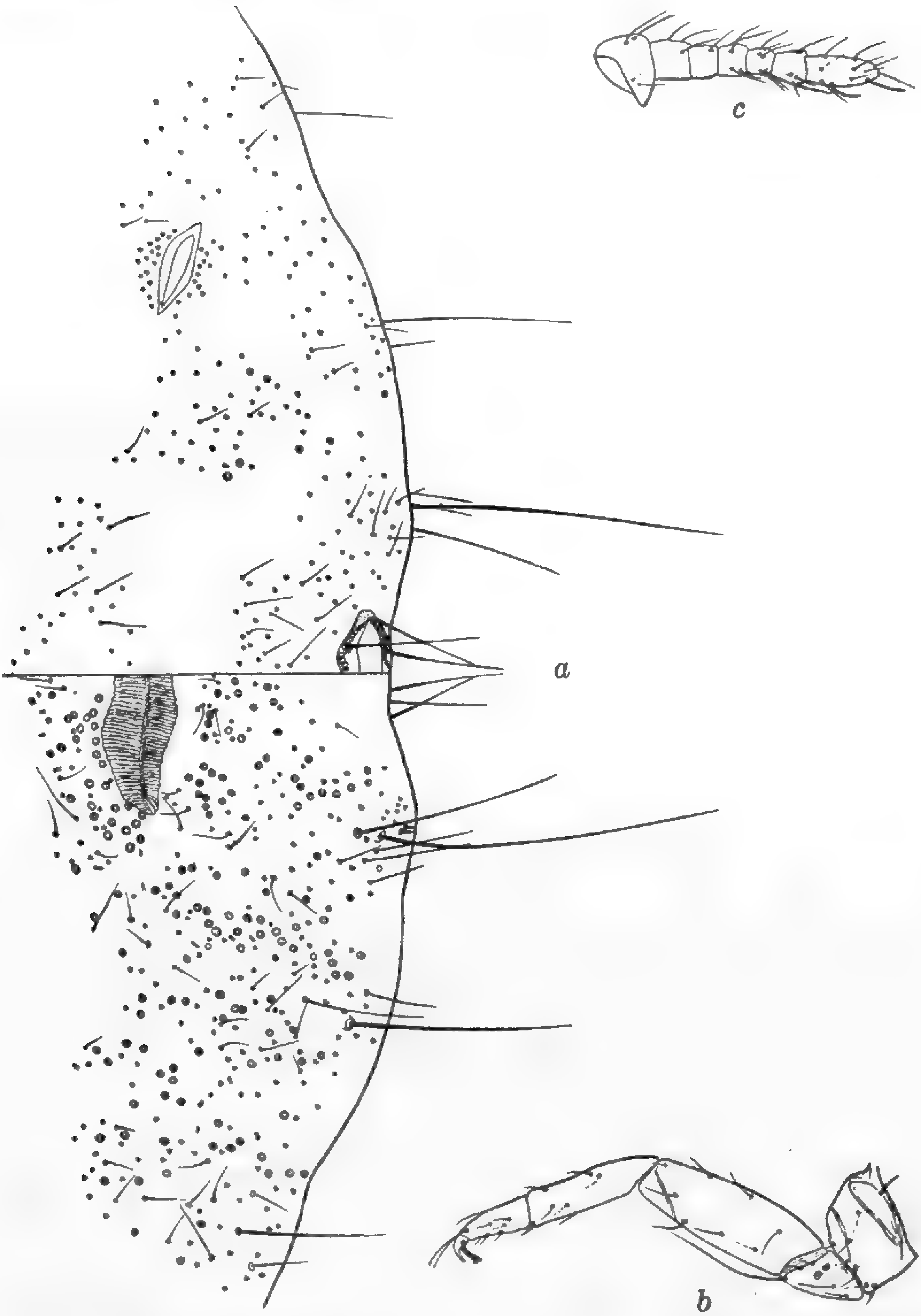


FIG. 15. *Pseudococcus sacchari* (Ckll.), adult female; *a*, posterior apex of abdomen, showing series of marginal hairs, etc., × 115; *b*, leg, × 115; *c*, antenna, × 115.

the records furnished by him, the material on which a record of the occurrence of this species in the Philippines is chiefly based was collected on "*Annona sativus*" at Manila (*Arce 2603*). I have consulted with Mr. W. E. Safford, of the Bureau of Plant

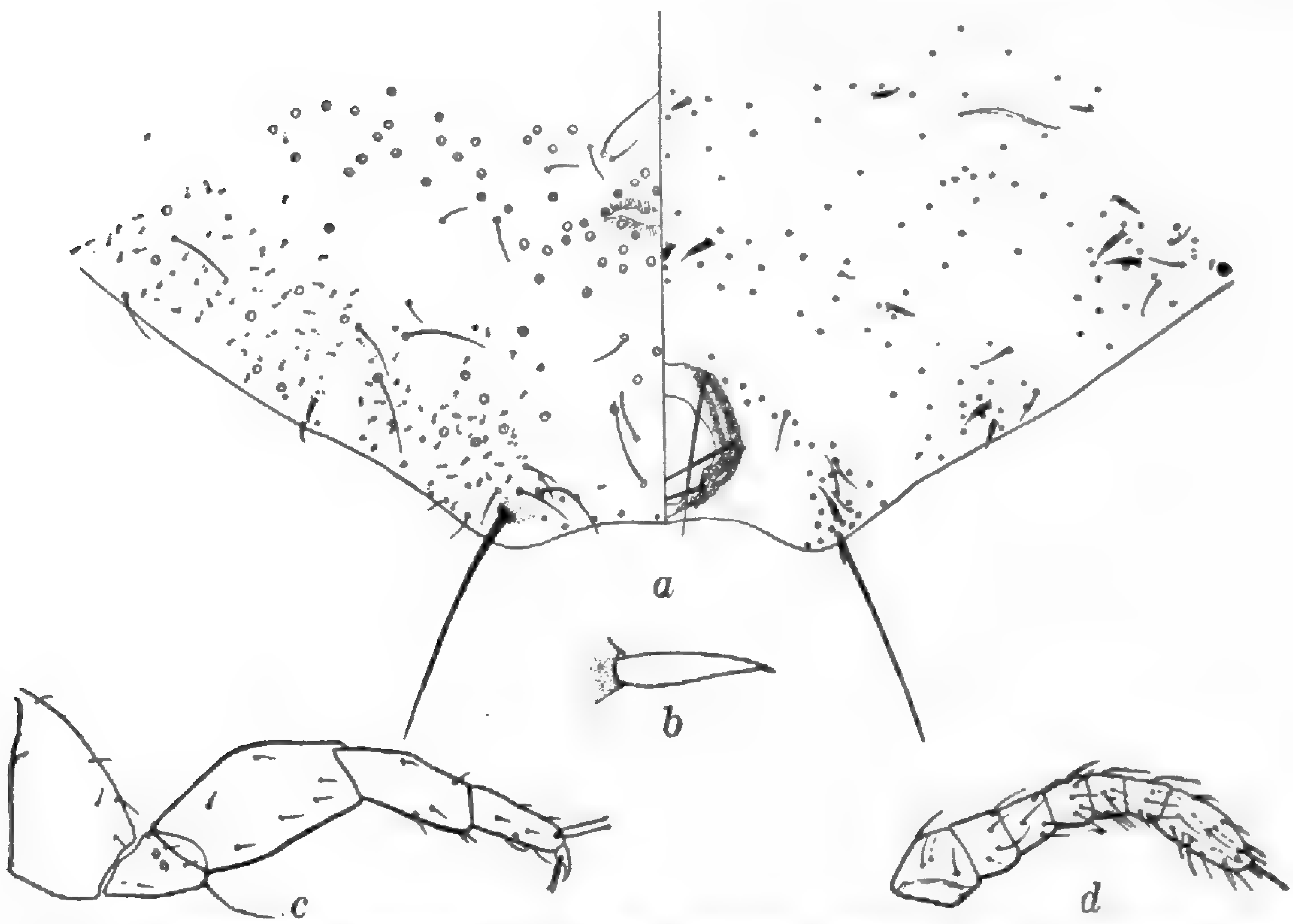


FIG. 16. *Pseudococcus filamentosus* (Ckll.), adult female; *a*, posterior apex of abdomen, showing cerarii, dorsal spines, anal setæ, anal ring, etc., × 115; *b*, dorsal spine, × 640; *c*, leg, × 115; *d*, antenna, × 115.

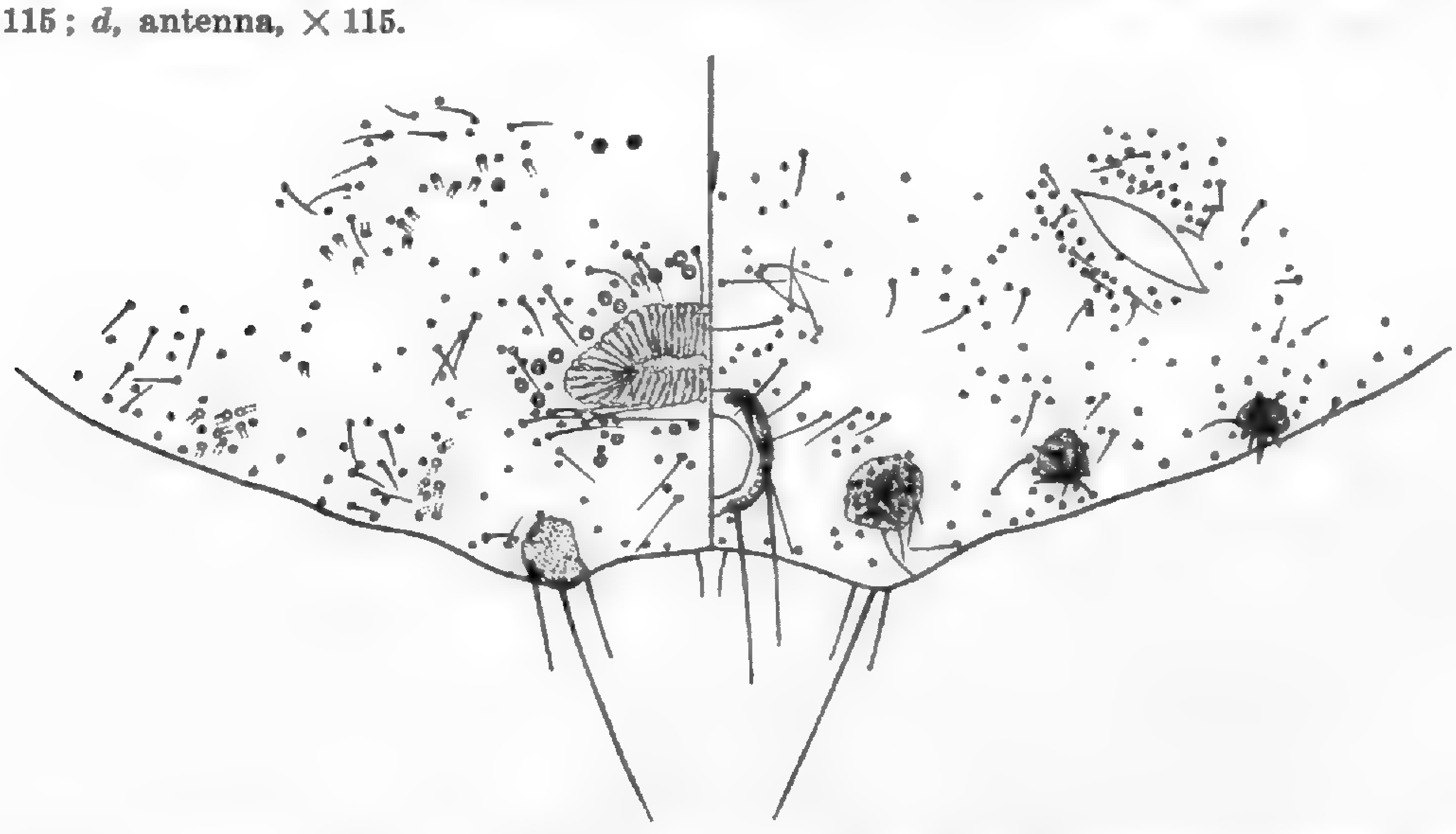

FIG. 17. *Pseudococcus bromeliae* (Bouché), adult female; end of abdomen, showing cerarii, apical setæ, ventral chitinized thickening, anal ring, etc., × 115.

Industry, United States Department of Agriculture, a specialist on the genus *Annona*, and he informs me that the specific name *sativus* has never been used in this genus. On the other hand, the name commonly given to the cultivated pineapple is *Ananas sativa*, and in view of the identity of the insect, it seems almost certain that the host record should be the latter name. The species has also been collected at quarantine, Washington, D. C., on banana received from the Philippines, by Mr. E. R. Sasscer.

**Pseudococcus lilacinus** Ckll.

*Pseudococcus lilacinus* COCKERELL, Proc. Dav. Acad. Sci. 10 (1905) 128; ROBINSON, Philip. Journ. Sci. § D 12 (1917) 7.

*Pseudococcus tayabanus* COCKERELL, Proc. Dav. Acad. Sci. 10 (1905) 129; ROBINSON, Philip. Journ. Sci. § D 12 (1917) 7.

*Dactylopius crotonis* GREEN, Tropical Agric. 24 (1905) 44 (without description); GREEN (as n. sp.), Journ. Econ. Biol. 6 (1911) 35, fig.

I am able to indicate the above synonymy through having type material of these three species available for examination, due to the kindness of the describers, Professor Cockerell and Mr. Green, in presenting material to the United States National collection of Coccidæ. The two lots of type material of Cockerell's species are very similar in general appearance before

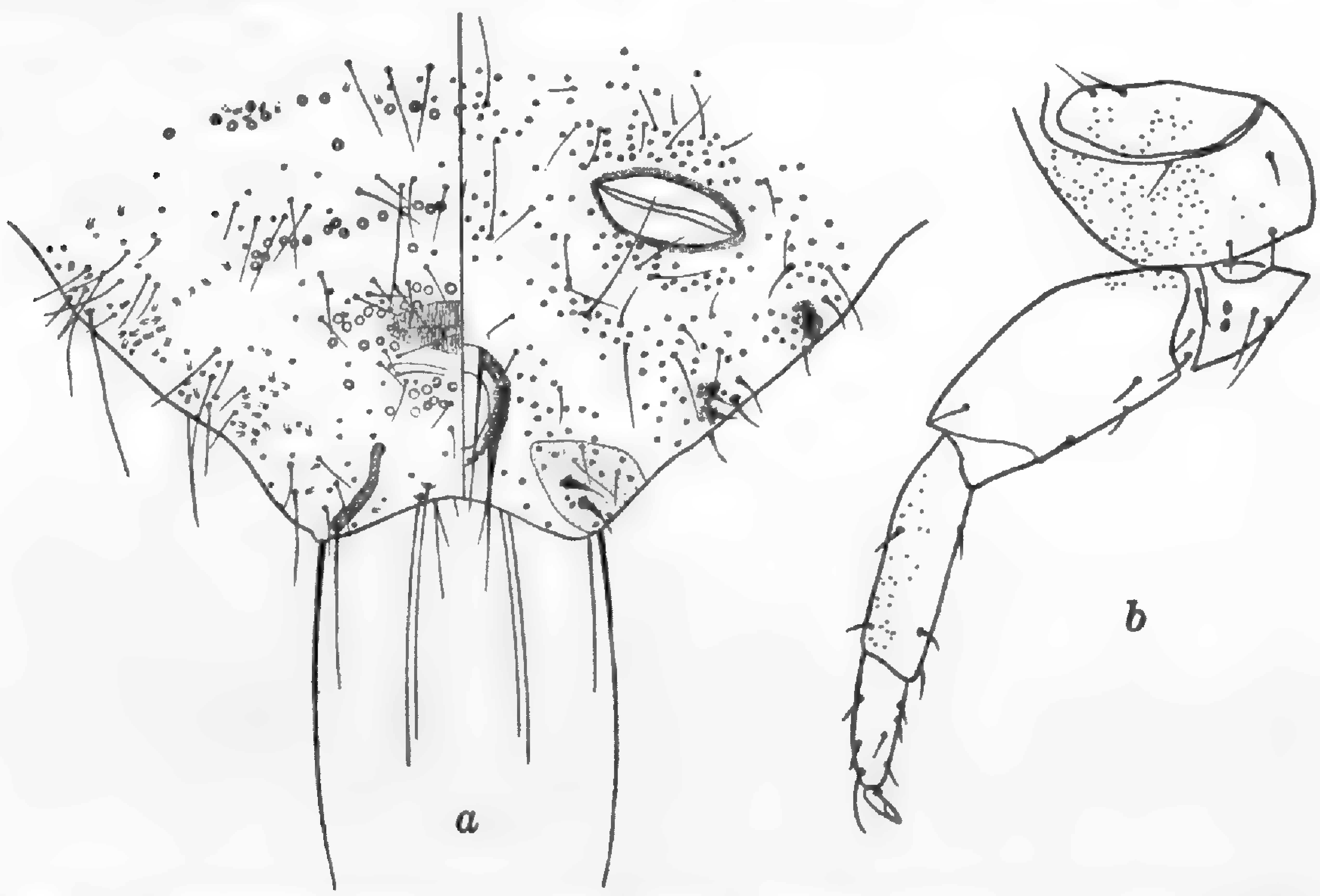


FIG. 18. *Pseudococcus lilacinus* Ckll., adult female; *a*, posterior apex of abdomen, showing cerarii, ventral chitinized thickening, anal ring, apical setæ, etc., × 115; *b*, hind leg, showing numerous minute pores on coxa and tibia, × 115.

mounting, and each is labeled "part of type"—of *lilacinus* and *tayabanus*, respectively. The two lots are of the same species so far as I have been able to determine from an extended study of mounted specimens. No attempt is made to account for the apparent discrepancy in regard to the color of the body after boiling in caustic potash, as given in the original description, although a possible explanation might be that the two species are really different, but that we had received two lots of the same species with different names attached. In the absence of any confirmation of this hypothesis it is only possible to place the second one described in the synonymy along with Green's *D. crotonis*.

Considering the wide distribution and wide range of host plants already recorded for this species, under its different names, it is my belief that it will ultimately be found to be some previously described species from another part of the world. It seems to be quite closely related to the common citrus mealy bug, *P. citri* (Risso), in many of its structural characters, but is viviparous, and has much stouter legs and antennæ.

Specimens from the following collections of Philippine material have been examined:

LUZON, Manila, on *Ficus cumingii* (*2605*), *Spondias purpurea* (*2595*), *Annona squamosa* (*2593*), *Annona glabra* (*2569*), and *Erythrina subumbrans* (*2604*) (all coll. *Arce*), bamboo (*Compere 20141*): Bulacan Province, Baliuag, on *Eugenia jambos* (coll. *Arce 2612*), on *Antidesma* sp. (coll. *Arce 2611*); Quingua, on *Premna odorata* (coll. *Arce 2610*), *Streblus asper* (coll. *Arce 2618*), *Semecarpus cuneiformis* (coll. *Arce 2613*): Laguna Province, Los Baños, on *Canangium odoratum* (coll. *Banks* (*18451*); Paete, on *Ficus ulmifolia* (coll. *McGregor*): Rizal Province, Balintauac, on *Ceiba pentandra* (coll. *Arce 2601*), on coffee (coll. *Arce 2600*), on *Psidium guajava* (coll. *McGregor*); Culi Culi, on *Streblus asper* (coll. *McGregor*); Fort William McKinley, on *Psidium guajava* (coll. *McGregor*); Pasig, on *Streblus asper* (coll. *McGregor*).

### Genus **ANTONINA** Signoret

This genus and its single Philippine species should be easily recognizable from the characters given in the key to genera.

**Antonina zonata** Green. Plate 1, fig. 6.

*Antonina zonata* GREEN, Ent. Month. Mag. 55 (1919) 175.

This is a plump, globular species found at the points where small bamboo stems branch, either beneath leaf sheaths or more or less exposed. In its dried condition it shrivels irregularly and is dark reddish brown in color, varying in size from 2 to 4 millimeters. The anal tube is surrounded by a somewhat circular, more heavily chitinized plate bearing numerous glands and hairs, and the anal ring setæ protrude half or more of their length beyond the mouth of the tube.

The species would appear to be at least fairly common from the records of material examined.

LUZON, Manila, on bamboo (coll. *Compere 20149*), on *Bambusa* sp. (coll. *Banks 10093*), on *Bambusa blumeana* (coll. *Arce 2598*): Bulacan Province, Baliuag (coll. *Banks 10151*).

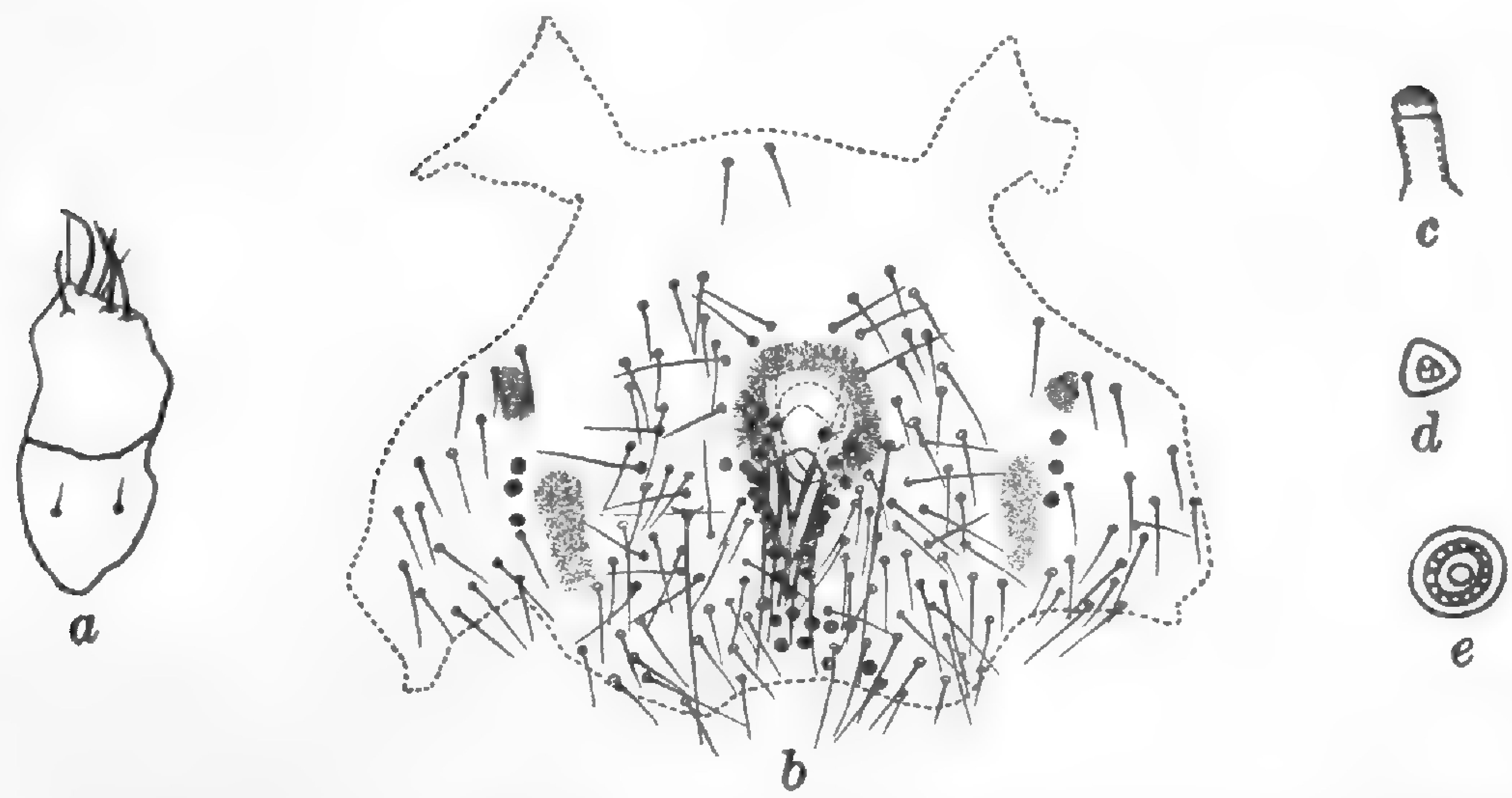


FIG. 19. *Antonina zonata* Green, adult female; *a*, antenna, × 335; *b*, anal plate and ring, × 115; *c* to *e*, different types of gland pores found on body, × 640.

## TACHARDIINÆ

This subfamily includes only a single known genus, which is sufficiently characterized in the key to subfamilies.

### Genus **TACHARDIA** R. Blanchard

This genus is now represented in the Philippines by two species, of which one has been previously reported from India, while the other is described as new in this paper. These species may be separated by the following key.

***Key to the Philippine species of Tachardia.***

$a^1$. Apex of spiracular processes or stigmatic plate large, circular or oval, with a broad chitinized area surrounding the central region containing numerous minute pores and about four to eight large tubular ducts, but no spines; posteriorly, near the anal lobe process, with several ball-like clusters of multilocular gland pores; plates surrounding the anal ring numerous, deeply and irregularly incised at apices; antennæ very short and stout ......... T. fici Green.

$a^2$. Apex of spiracular processes smaller, with a ridge surrounding a circular to oval area containing from two to six scattered pores and from nine to eleven conical spines, but no tubular ducts; without multilocular disk gland pores, except those near the spiracles; with sixteen clusters of peculiar gland ducts around the body margin; with only two plates and a few heavy spines around the anal ring; antennæ, while reduced, longer, fingerlike................ T. minuta sp. nov.

**Tachardia fici** Green.

*Tachardia fici* GREEN, Ind. Mus. Notes 5 (1903) 97.

This record is based on specimens collected at Manila from the aërial roots of a banyan tree (coll. *Compere 20157*).

This species appears to be very closely related to the common lac insect, *Tachardia lacca* Kerr.

Tachardia minuta sp. nov. Plate 1, fig. 4.

*Adult female.*—Occurring on the leaves of the host, mostly on the underside along the midrib; test somewhat egg-shaped, broadest behind, but with a constriction on each side about the middle, strongly convex, broadly ribbed laterally, this more pronounced on the anterior portion, posterior dorsal opening oval, located just at the end of the larval exuvium, the anterior pair of openings diagonally slitlike, placed just before the exuvium; maximum length, about 1.5 millimeters; color dark reddish to almost black.

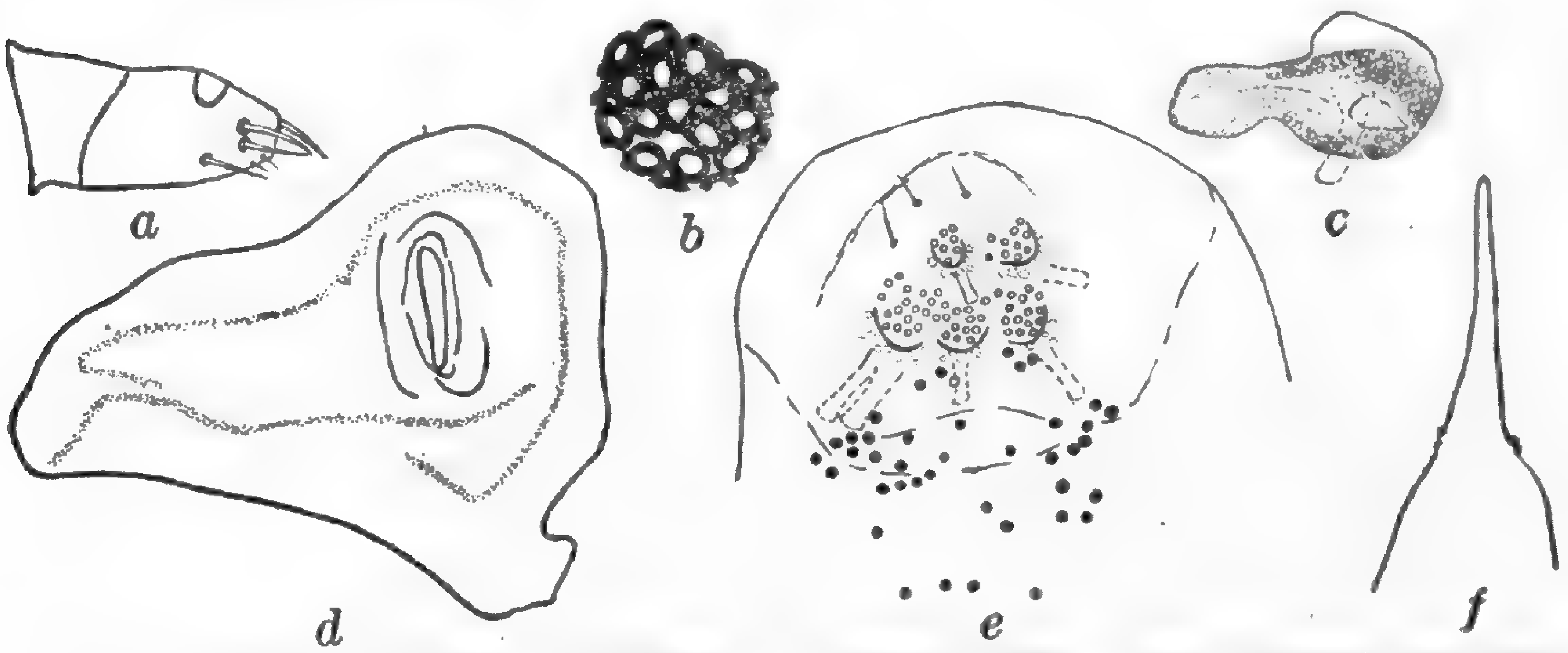


FIG. 20. *Tachardia fici* Green, adult female; *a*, antenna, × 335; *b*, group of gland pores from near anal lobe, × 640; *c* and *d*, spiracles, × 165; *e*, stigmatic plate, × 165; *f*, dorsal spine, × 165.

*Body of female.*—Shaped much as is the test; antennæ small, fingerlike, apparently 2-segmented, terminating in a chitinized plate bearing two long, stout, and two tiny, spines; total length, not including spines, about 53 $\mu$, but variable; length of spines, about 12 $\mu$; small spiracles strongly constricted medially, the larger nearly straight, several times larger than the smaller pair; spiracular processes apparently elongate, cylindrical, each terminating in a roughly circular chitinized plate bearing a large oval ring inclosing spines and pores, spines averaging nine to eleven in number, pores, two to six; the lobe bearing dorsal spine shorter than spine, stout, tapering somewhat, the spine about 80 to 90 $\mu$ long by 53 $\mu$ wide at base, basal third tapering strongly, the remainder very gradually, tip rounded, slender apical portion straight or slightly curved; anal lobe somewhat chitinized, the apical cap more than the rest, conical-rounded in shape with anal ring set in deeply at apex and surrounded by lobes and spines, the arrangement of the latter difficult to determine with certainty, but apparently posteriorly with two large lobes with a deep notch between them and with their apices more or less irregular or incised, laterally with two or three protuber-

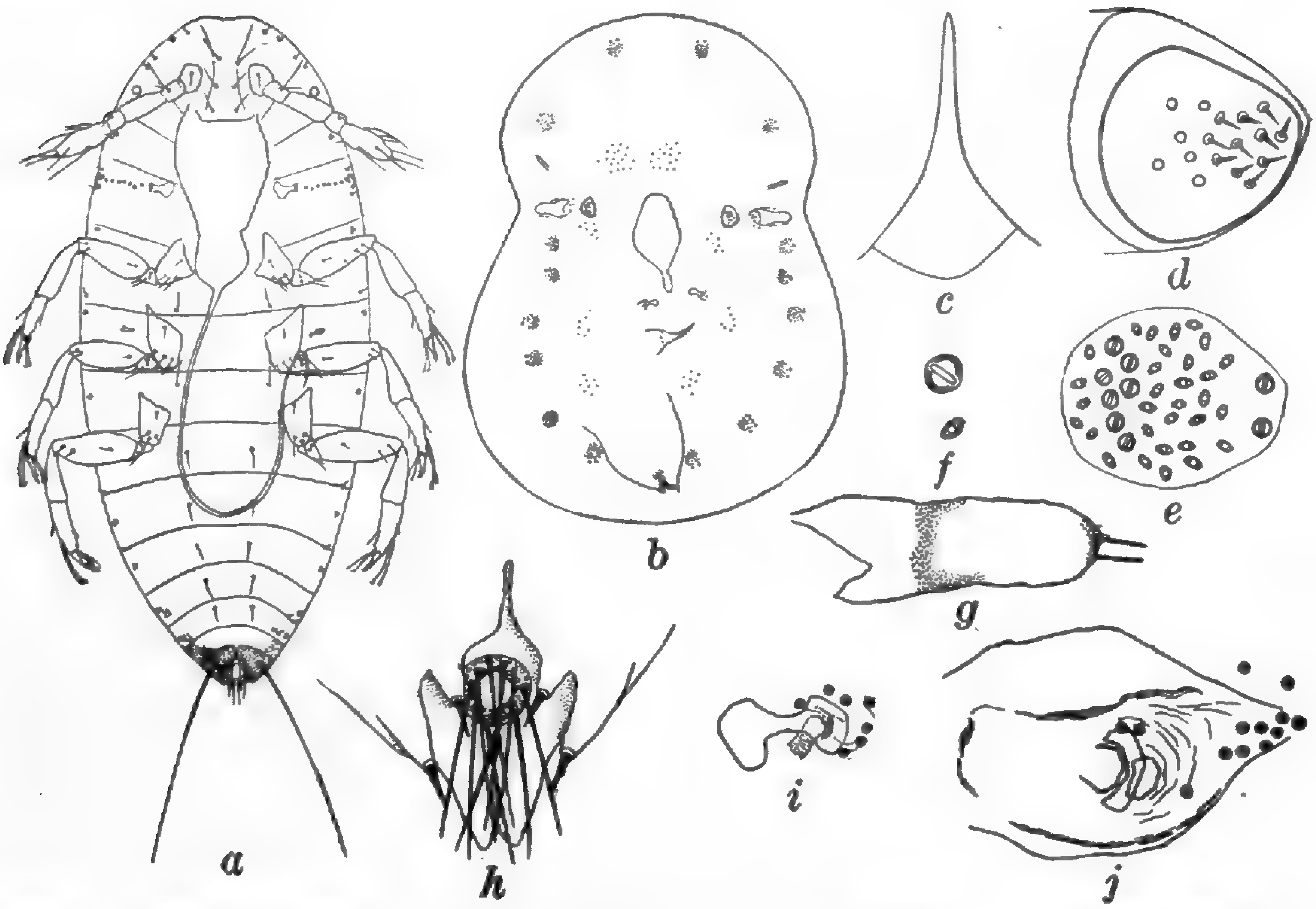


FIG. 21. *Tachardia minuta* sp. nov., young larva; *a*, from beneath, × 165; adult female, *b*, outline of body, showing position of various organs, × 38.5; *c*, dorsal spine, × 230; *d*, stigmatic plate, × 335; *e*, marginal group of gland pores, × 335; *f*, details of pores in same, × 640; *g*, antenna, × 335; *h*, apex of anal lobe, × 335; *i* and *j*, spiracles, × 335.

ances or tubercles on each side, each of these bearing a large stout spine, and anteriorly with the margin curving down more or less irregularly between the first spine on each side; anal ring with ten hairs, the longest about 50 $\mu$, the division of each lateral half of the ring into upper and lower portions indistinct or incomplete; apparently with only a single type of gland over the body, but with a few circular, indistinctly quinquelocular gland pores near each spiracle; body gland pores peculiar in appearance, but so minute that it has not been possible to determine the structure definitely; apparently oval to circular, and either trilocular, with the loculi in a single row, or obscurely quadrilocular with one pair of loculi larger than the other, these in two sizes, the smaller occurring scattered in the body margin region, in about four small loose clusters, forming a row on each side, and outside of this row in sixteen compact clusters, surrounded by faint chitinization, running clear around the body, of which clusters the four anterior are the largest, the large pores occurring only in these last clusters, in which there are two on the outer edge of each cluster except the fifth and sixth from the caudal apex on each side, these having only one, and from two to eight in the inner half of each cluster, the latter surrounded by smaller pores.

*Young (embryonic) larva.*—Elongate oval, about 346 $\mu$ long by 150 $\mu$ wide, antennæ 6-segmented, the third and sixth longest, legs small, tarsal claw with denticle, all digitules long and slender; with a notch opposite the anterior spiracle, bordered in front by two and behind by one spear-shaped spine and with a single row of relatively large pores leading to spiracle; anal ring surrounded by a chitinized area, with six or eight setæ.

This species has been described from several females mounted on slides and some additional unmounted material, all collected on *Mangifera indica* at Isabela, Basilan, December, 1918 (*S. A. Reyes*), and forwarded by Professor Baker under No. *10102*. The types are in the United States National collection of Coccidæ.

This is the smallest species of this genus known to me. In its morphological characters it seems quite close to *Tachardia aurantiaca* Ckll., from which it differs in size, in having circular apices to the spiracular processes, with only a few spines and pores, instead of having a large triangular cap with a cluster of spines at one end and of pores at the other, and in other characters.

## COCCINÆ

Members of this subfamily should be readily recognizable from the characters given in the subfamily key, since all the species have the pair of anal plates well developed, and all but *Ceroplastes* and *Vinsonia* show the anal cleft distinctly, while the heavy coating of solid wax covering the species of these genera is sufficient to distinguish them from any other Philippine coccids, with the possible exception of *Tachardia*. Species representing nine genera of the subfamily, as they are at present recognized, have been collected in the Philippines.

### *Key to the Philippine genera of the Coccinæ.*

$a^1$. Marginal spines slender, linear, at most somewhat dilated and frayed at apices.

$b^1$. Body of female covered with and adherent to a thick coating of waxy or glassy secretion; spiracular spines usually numerous, stout, conical or bullet-shaped, clustered or spread out along the margin of the body.

$c^1$. Cephalic apex of body separated from remainder by a distinct suture; covering secretion of body extended into fingerlike prolongations, the whole giving the appearance of a 7-rayed star with hemispherical center.......................................... **Vinsonia Sign.**

$c^2$. Without a separated cephalic lobe; waxy covering of body not protruding as in the preceding..... .............................. **Ceroplastes Gray.**

$b^2$. Female not covered with wax or, if present, this very thin and easily separable from the body, transparent and glassy; spiracular spines usually with three or less in each group, rarely more.

$d^1$. Abdomen dorsally without compound "cribriform plates," three on each side of the anal opening; antennæ and legs present and at least fairly well developed.

$e^1$. With only a single, very long, spiracular spine opposite each spiracle; body inclosed in, but not attached to, a glassy test or sac.......... Ceroplastodes Ckll.

$e^2$. With three or more spiracular spines in each group; body not inclosed in a glassy test.

$f^1$. Each anal plate very much longer than wide, these plates located near the center of the body; body more or less triangular with rounded angles; flat, with a small ovisac bordering the posterior margin of the body of the adult (cf. *Coccus* spp. if without ovisac) .......... Protopulvinaria Ckll.

$f^2$. Each anal plate more nearly triangular, the anterolateral margin usually only a little longer than the posterolateral, if much longer without ovisac in adult female; anal plates located nearer the posterior end of the body than the anterior; ovisac either wanting or very well developed; body slightly convex to hemispherical.

$g^1$. Adult female secreting a well-developed posterior ovisac and, sometimes, a cottony pad on which it rests. Pulvinaria Targ.

$g^2$. Adult female not secreting a posterior ovisac.

$h^1$. Body convex to strongly hemispherical; derm with large, heavily chitinized, polygonal or oval cells, each with a central pore.......... Saissetia Despl.

$h^2$. Body only slightly convex; derm without the large, closely crowded, polygonal or oval areas, although sometimes with widely separated circular or oval areas .......... Coccus Linn.

$d^2$. Abdomen dorsally with six compound "cribriform plates," arranged in a semicircle, three on each side of and anterior to the anal plates; antennæ and legs rudimentary or absent. Platylecanium Ckll. and Rob.

$a^2$. Marginal spines much enlarged, flattened, broadly fan-shaped; body flat, broad-oval to nearly circular.......... Paralecanium Ckll.

## Genus PULVINARIA Targioni Tozzetti

This genus as at present recognized is characterized only by the full development of a posterior ovisac in the adult female. In the Philippine species the ovisac is well developed when completely formed, and the anal plates of all species have the posterolateral and anterolateral margins about equal in length, in contrast to *Protopulvinaria*, which has at times been included in

*Pulvinaria.* Four species and one variety have been reported from the Philippines, but I believe that the variety is invalid.

*Key to the Philippine species of Pulvinaria.*

$a^1$. Marginal spines large, stout, cylindrical or slightly tapering, and truncate at apices........ P. thespesiæ Green.
$a^2$. Marginal spines more slender, acute apically, or flattened and incised or fimbriated, never truncate, and much slenderer than spiracular spines.
  $b^1$. Spiracular spines in each group four or five, one longer than the others, very rarely with only three in a group; marginal spines slender, the apices more or less fimbriated........ P. polygonata Ckll
  $b^2$. Spiracular spines in each group normally three, one longer than the other two; marginal spines more or less distinctly flattened toward apices and incised at tips.
    $c^1$. Marginal spines typically flattened at apices, but not or only very slightly broadened, strongly incised; mature female apparently without dorsal secretion........ P. tyleri Ckll.
    $c^2$. Marginal spines typically distinctly broadened and incised apically, as well as flattened; mature female with more or less cottony or waxy secretion dorsally........ P. psidii Mask.

**Pulvinaria thespesiæ Green.**

*Pulvinaria thespesiæ* Green, ROBINSON, Philip. Journ. Sci. § D 12 (1917) 10.

The truncate marginal spines and the numerous spiracular spines of this species, as shown in the accompanying figure, make it readily recognizable among the other Philippine species. The following is the record of the material examined:

LUZON, Manila, on *Samanea saman* (coll. *Compere*), on *Zizyphus jujube* (coll. *Arce 2571*): Bulacan Province, Baliuag, on *Jatropha curcas* (coll. *Arce 2607*): Laguna Province, Los Baños (coll. *Banks 18465*): Rizal Province, Montalban, on *Homonoia riparia* (coll. *McGregor*).

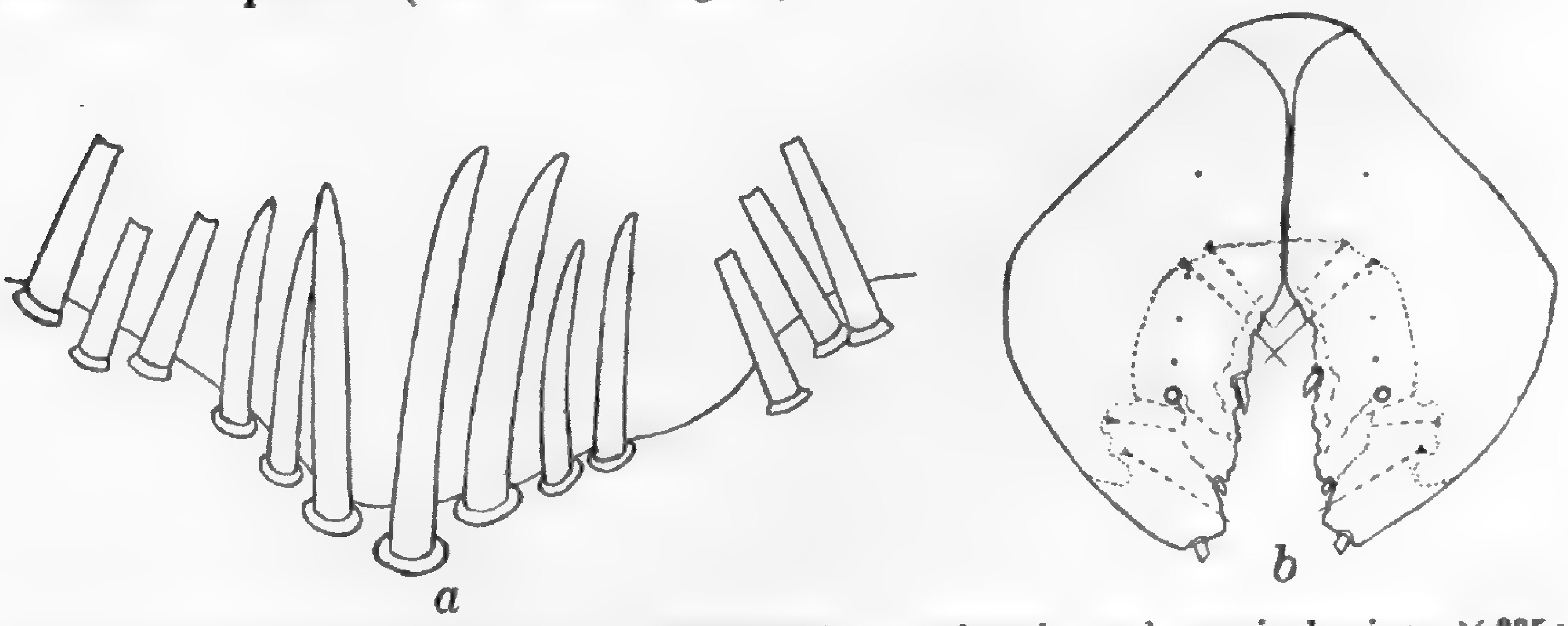


FIG. 22. *Pulvinaria thespesiæ* Green, adult female; *a*, spiracular and marginal spines, × 335; *b*, anal plates from above, × 165.

**Pulvinaria polygonata** Ckll. Plate 1, fig. 9.

*Pulvinaria polygonata* Ckll., ROBINSON, Philip. Journn. Sci. § D 12 (1917) 10.

*Pulvinaria cellulosa* GREEN, Cocc. Ceylon, pt. 4 (1909) 262.

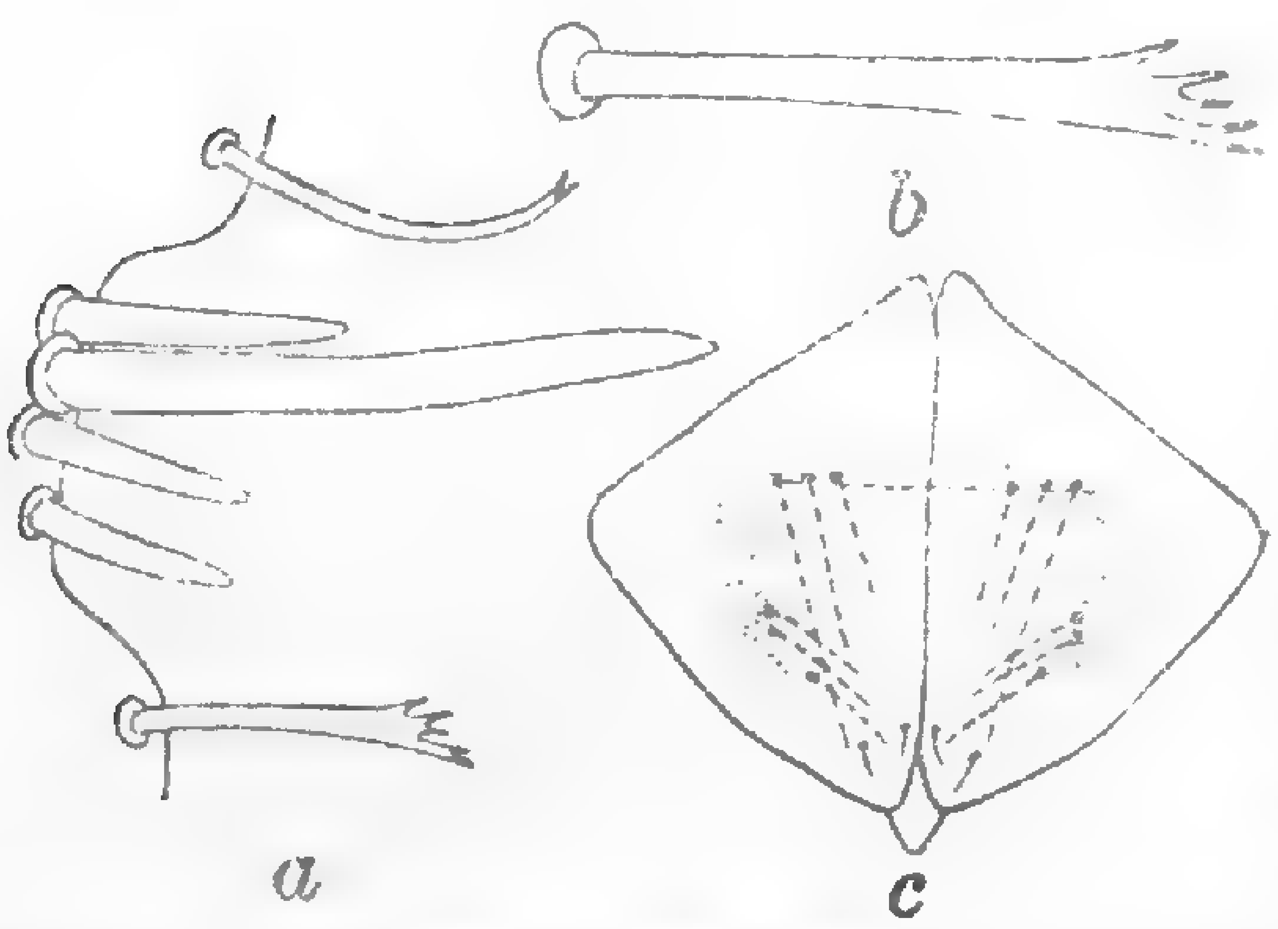


FIG. 23. *Pulvinaria polygonata* Ckll., adult female; *a*, spiracular and marginal spines, × 335; *b*, detail of marginal spine, × 640; *c*, anal plates from above, × 165.

Through the kindness of the describers of these two species in sending to the United States National collection of Coccidæ cotype material of each, it has been possible to make a direct comparison of specimens resulting in the synonymy indicated above. It is unfortunate that Green's species, which is excellently described and figured, should have to fall. In addition to the type material the following specimens have been examined:

LUZON, Manila, on orange (coll. *Compere*): Laguna Province, Los Baños, on *Citrus nobilis* (coll. *Baker 10096, 10097*).

**Pulvinaria tyleri** Ckll.

*Pulvinaria tyleri* Ckll., ROBINSON, Philip. Journn. Sci. § D 12 (1917) 9.

This species is somewhat doubtfully separated from the following, and it is possible that further study may show it to be some other already described species. In any event, this and the following are very closely related, but it is possible in the material at hand to separate two groups of specimens which show a somewhat different appearance of the marginal spines, those of

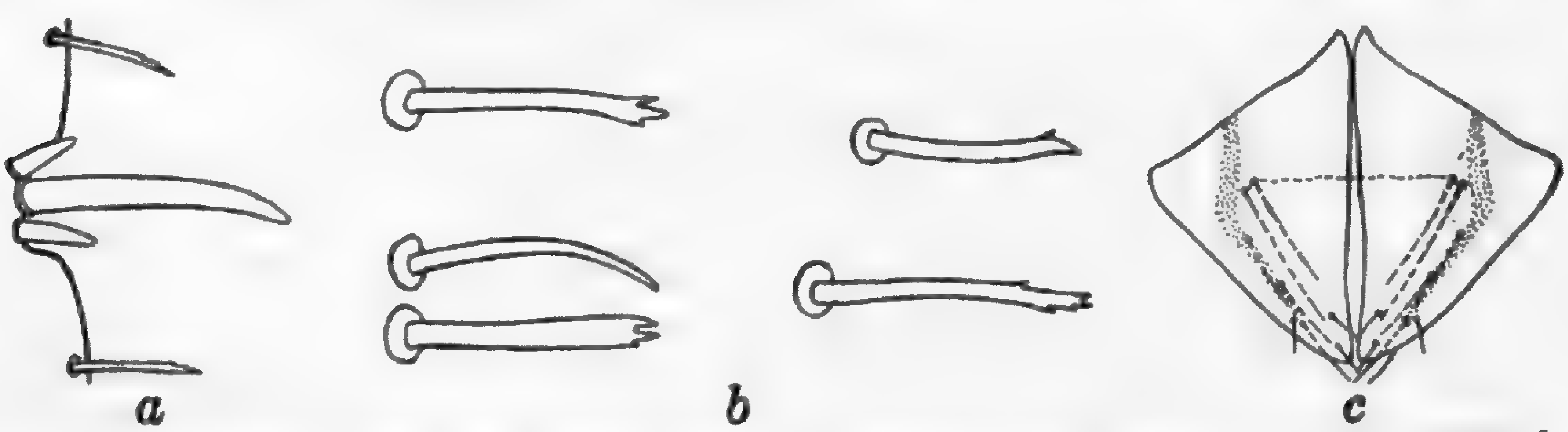


FIG. 24. *Pulvinaria tyleri* Ckll., adult female; *a*, spiracular and marginal spines, × 335; *b*, details of marginal spines, × 640; *c*, anal plates, × 165.

this species appearing longer and slenderer and only very slightly expanded at tips, in contrast to the typical condition in *Pulvinaria psidii*. There appears to be considerable normal variation in the spines of both species, and this appearance is increased through alterations from the normal position for the spine, as when one is turned on edge, when viewed from above, or is foreshortened through curving up or down. Unfortunately all of the gross material examined is in very poor condition, so it is not possible to learn anything of the normal appearance of the adult female after the secretion of the ovisac, nor to obtain any very good mounted specimens. The lots of material included here are as follows:

LUZON, Manila, on various plants (coll. *Compere*), on *Antigonon leptopus* (coll. *Banks 14375*): Batangas Province, Batangas, on "Cadena de amor" (coll. *C. H. T. Townsend*) (type material): Rizal Province, San Pedro Makati, on *Lantana camara* (coll. *McGregor*). The type slide includes only three badly parasitized and mutilated specimens, and all of the material studied shows a decided degree of parasitism.

Pulvinaria psidii Mask.

*Pulvinaria psidii* Mask., ROBINSON, Philip. Journ. Sci. § D 12 (1917) 10.

*Pulvinaria psidii philippina* Ckll., ROBINSON, Philip. Journ. Sci. § D 12 (1917) 11.

A comparison of the type specimens of the subspecies listed above with the type specimens of Maskell's *Pulvinaria psidii* fails to disclose any characters by which I am able to differentiate the two. All of the specimens of the subspecies that have been examined unfortunatately have the antennæ broken off, but no other characters which would separate it from the typical material have been found, and in view of the well-known lack of constancy in the number of antennal segments in this and other groups of coccids, this material does not seem worthy of subspecific rank on the basis of this one character.

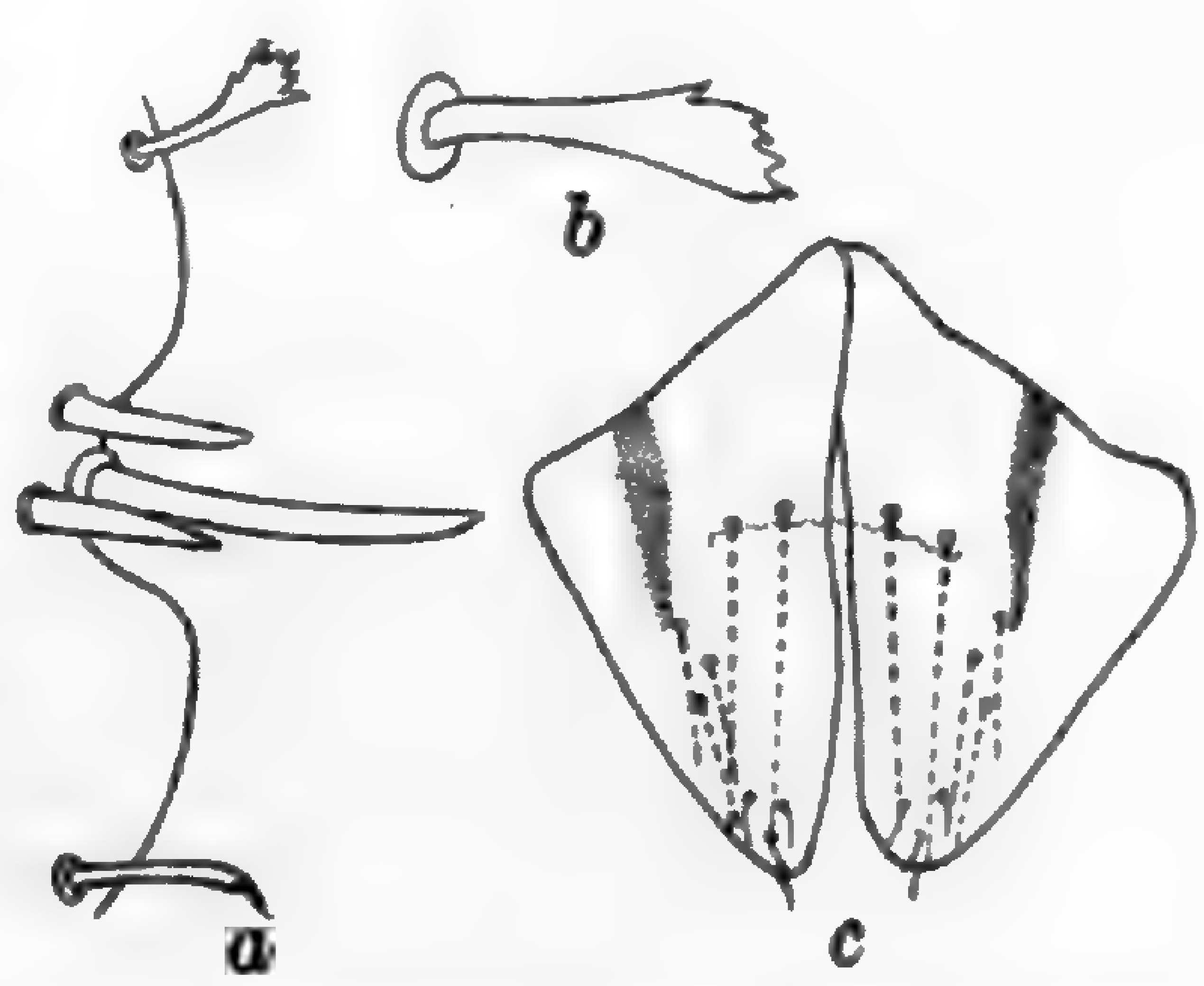

FIG. 25. *Pulvinaria psidii* Mask., adult female; *a*, spiracular and marginal spines, × 335; *b*, detail of marginal spine, × 640; *c*, anal plates from above, ×165.

The following records may be added to those previously published:

LUZON, Manila, on *Eugenia jambolana* (*10210*) and on unknown host (*10212*) (*Banks*), on unknown host (*Frank Dean*): Bulacan Province, on guava (*McGregor*): Laguna Province, Los Baños, on *Psidium guajava* (coll. *J. de Leon, Banks 13452*).

## Genus **PROTOPULVINARIA** Cockerell

The single Philippine species of this genus might possibly be confused with two species of the genus *Coccus* in its immature stages prior to the formation of the fringe of white secretion around the posterior portion of the body, although in reality the tremendous length of the anal plates in relation to their width, together with the character of the marginal hairs, makes this species easily recognizable; but to prevent confusion, the species has been included in the key to the species of the genus *Coccus.*

**Protopulvinaria longivalvata** Green.

*Protopulvinaria longivalvata bakeri* COCKERELL and ROBINSON, Bull. Am. Mus. Nat. Hist. 33 (1914) 332, fig. 9; ROBINSON, Philip. Journ. Sci. § D 12 (1917) 9.

A careful comparison of type specimens of Green's species and Cockerell's subspecies has been possible on account of the receipt of such material from both of these men. While there is recognizable a tendency toward those differences indicated by

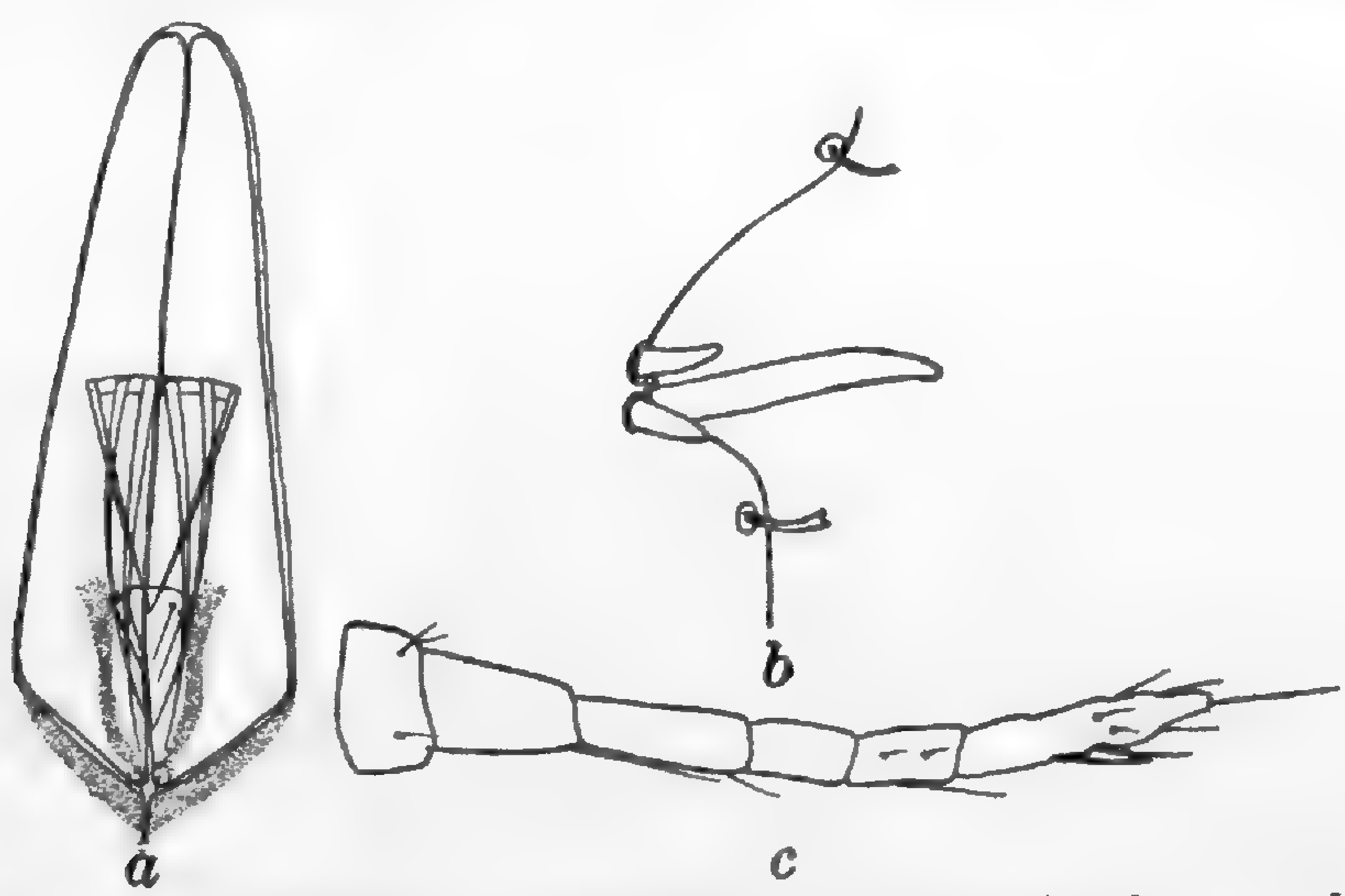


FIG. 26. *Protopulvinaria longivalvata* Green, adult female; *a*, anal plates, × 115; *b*, spiracular and marginal spines, × 640; *c*, antenna, × 165.

Cockerell when describing *bakeri,* I have been unable to conclude that the subspecies is based on anything that is not covered by individual variation. Both Green and Cockerell state that the antennæ are 8-segmented, yet a majority of the antennæ on the specimens available for examination are 7-segmented; with this much variation to begin with, any further consideration of the relative lengths of antennal segments seems quite futile. In addition to the type material of Cockerell's subspecies, material on *Piper betle* var., from Paete, Laguna Province, Luzon (*McGregor*) has been examined.

## Genus **VINSONIA** Signoret

The single species included in this genus is represented by one lot of material from the Philippines.

**Vinsonia stellifera** (Westw.). Plate 1, fig. 10.

*Coccus stellifera* WESTWOOD, Proc. Ent. Soc. London (1871) 3, 111.

The external appearance and other characters of this species, as given in the key, are such that it can hardly be confused with any other coccid now known to occur in the Philippines.

The material examined was collected at Manila on mango (*Compere*). Green [9] gives an excellent account and figures of this species.

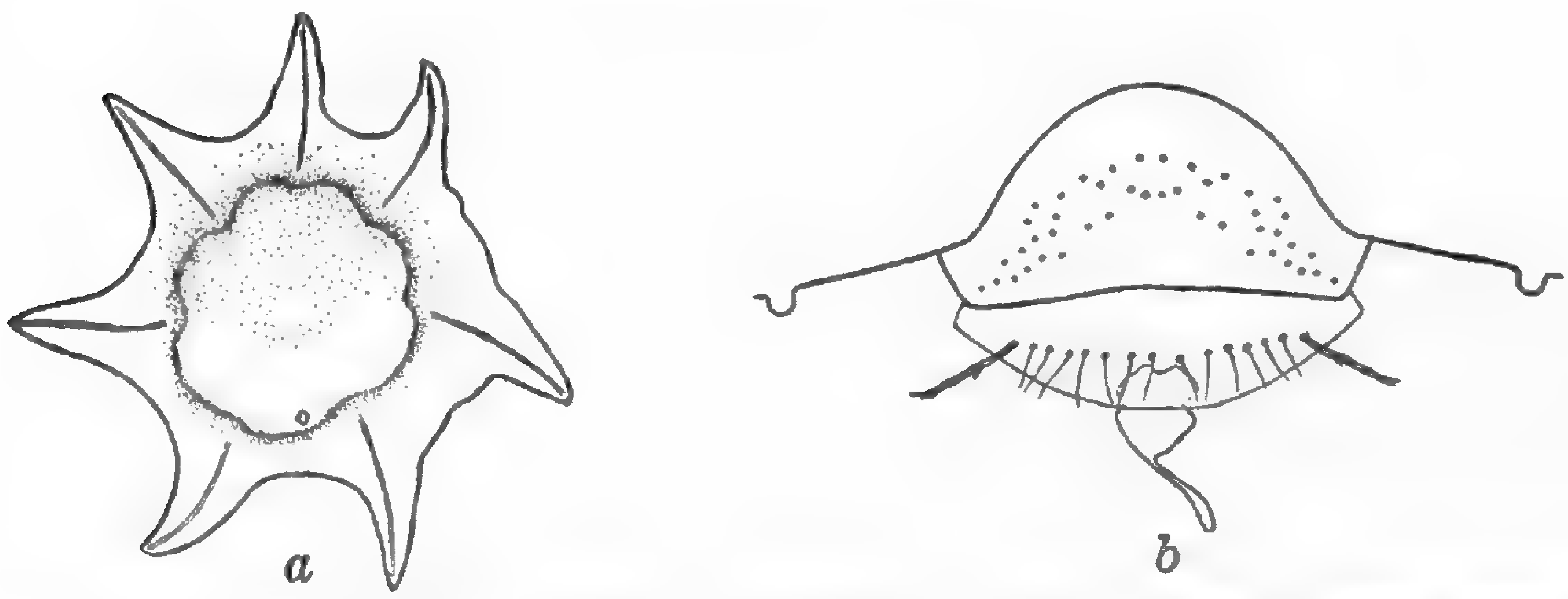


FIG. 27. *Vinsonia stellifera* (Westw.), adult female; *a*, outline of body, showing pointed secretionary projections, × 12; *b*, anterior portion of body, showing suture separating off the "head" and the antennæ, × 57.5.

## Genus **CEROPLASTES** Gray

The thick waxy covering of the species of this genus makes their recognition an easy matter. Only a single species has been known from the Philippines heretofore, but through the collections received it is possible to add two others, while in all probability it will be possible to make still further additions when more specimens of certain collected lots of material are available for study.

*Key to the Philippine species of Ceroplastes.*

$a^1$. Size very large, length, about 17.5 millimeters; wax white, with a deep dorsal median pit.................................................... C. gigas Ckll.[10]

$a^2$. Size smaller, usually not more than 12 millimeters; without a dorsal median pit.

[9] Coccidae of Ceylon pt. 4 (1909) 280.

[10] Included in the key from the original description only; no specimens examined.

$b^1$. Anal opening at the end of a long, nearly cylindrical, chitinized tube; spiracular spines numerous, mostly bullet-shaped; color of wax in life white or cream; size large, usually 10 to 12 millimeters. **C. ceriferus** (And.).

$b^2$. Anal opening on a short conical process; with one large conical and numerous globular spiracular spines; color in life rose red or grayish pink with conspicuous lateral white stripes; maximum length usually about 4 to 5 millimeters ........ **C. rubens** Mask.

**Ceroplastes ceriferus** (And.).

*Coccus ceriferus* ANDERSON, Mon. Cocci ceriferi (1791).

If the characters given in the preceding key will not easily separate this species from the other known Philippine species, reference may be made to Green [11] where an excellent description

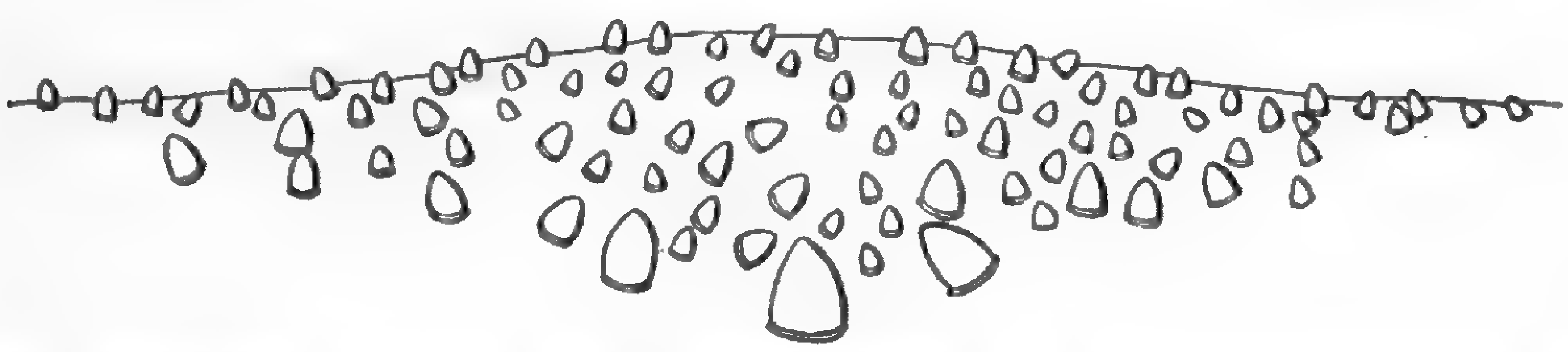

FIG. 28. *Ceroplastes ceriferus* (And.), adult female; group of spiracular spines, × 165.

and figures are given, both for this and the following species. I have examined material, all in bad condition, of this species from Los Baños, Laguna Province, on *Phytocrene* (coll. *Baker 2373*) and on *Ficus hauili* (coll. *Banks 18400*).

**Ceroplastes rubens** Mask.

*Ceroplastes rubens* MASKELL, Trans. N. Z. Inst. 25 (1892) 214.

I have examined specimens of this species from Manila on "palm, etc." (coll. *Compere 20180*), and on *Psidium guajava* (coll. *Banks 10624*). After death and some drying the specimens become dull yellowish brown and the wax becomes translucent.

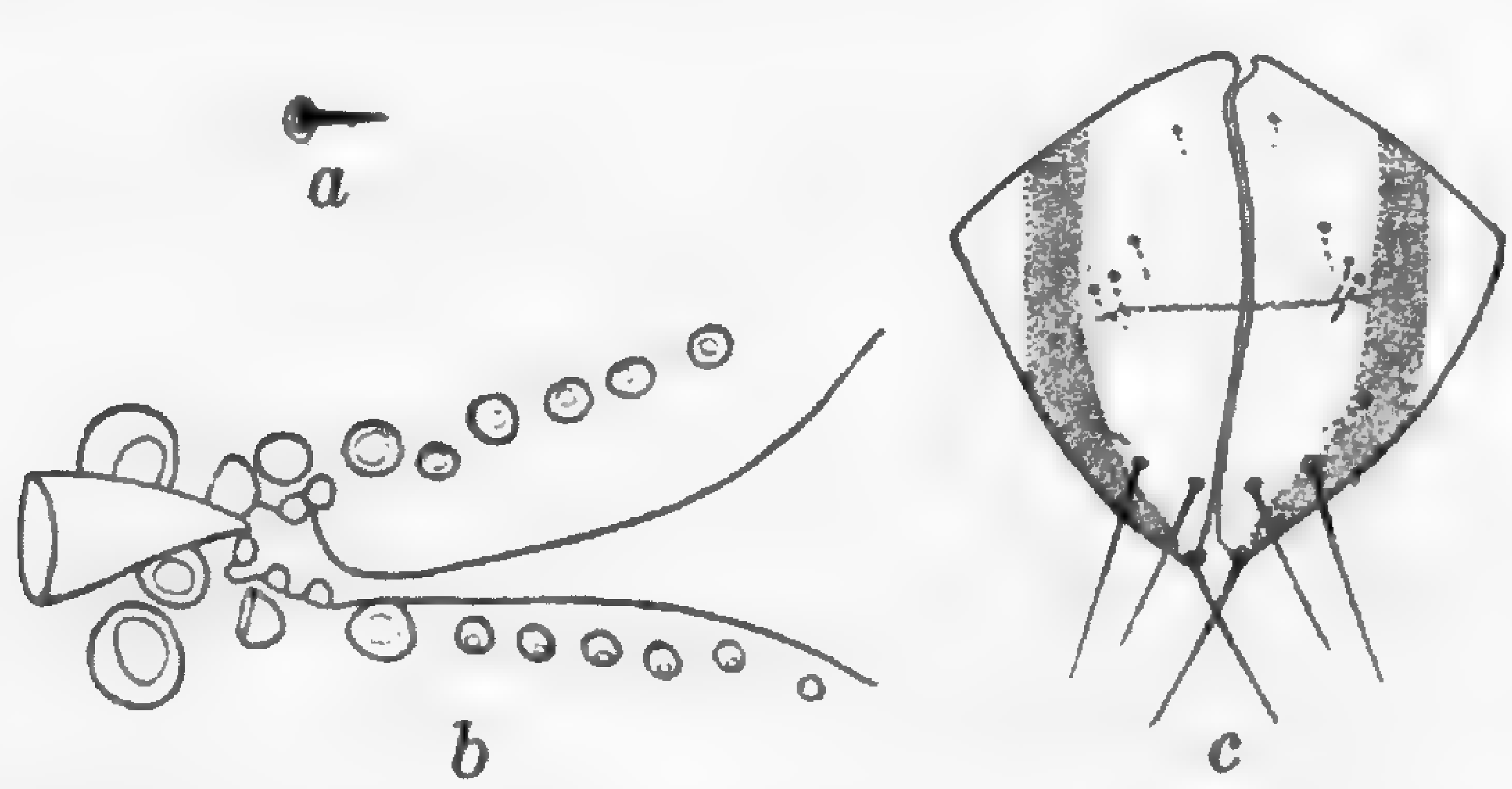


FIG. 29. *Ceroplastes rubens* Mask., adult female; *a*, marginal spine, × 640; *b*, spiracular spines, × 165; *c*, anal plates from above, × 165.

[11] Coccidae of Ceylon, pt. 4 (1909) 270.

## Genus CEROPLASTODES Cockerell

The species of this genus are characterized by the presence of a glassy test which retains its stout oval shape while the adult female shrinks and shrivels into the anterior end as she deposits her eggs. This test is variously ornamented externally according to the species, and is usually extremely brittle, at least in dried specimens. Only a single species has been collected in the Philippines so far.

**Ceroplastodes cajani** (Mask.).

*Eriochiton cajani* Maskell, Ind. Mus. Notes 2 (1891) 61.

Specimens which are apparently this species, although in very poor condition, are in Mr. Geo. Compere's collections from Manila, the first lot from guava (*1221*), the second on an unnamed host plant (*10243*). The generic characters already given should be sufficient to place this species, although here again reference may be had to Green [12] for an extended description and figures.

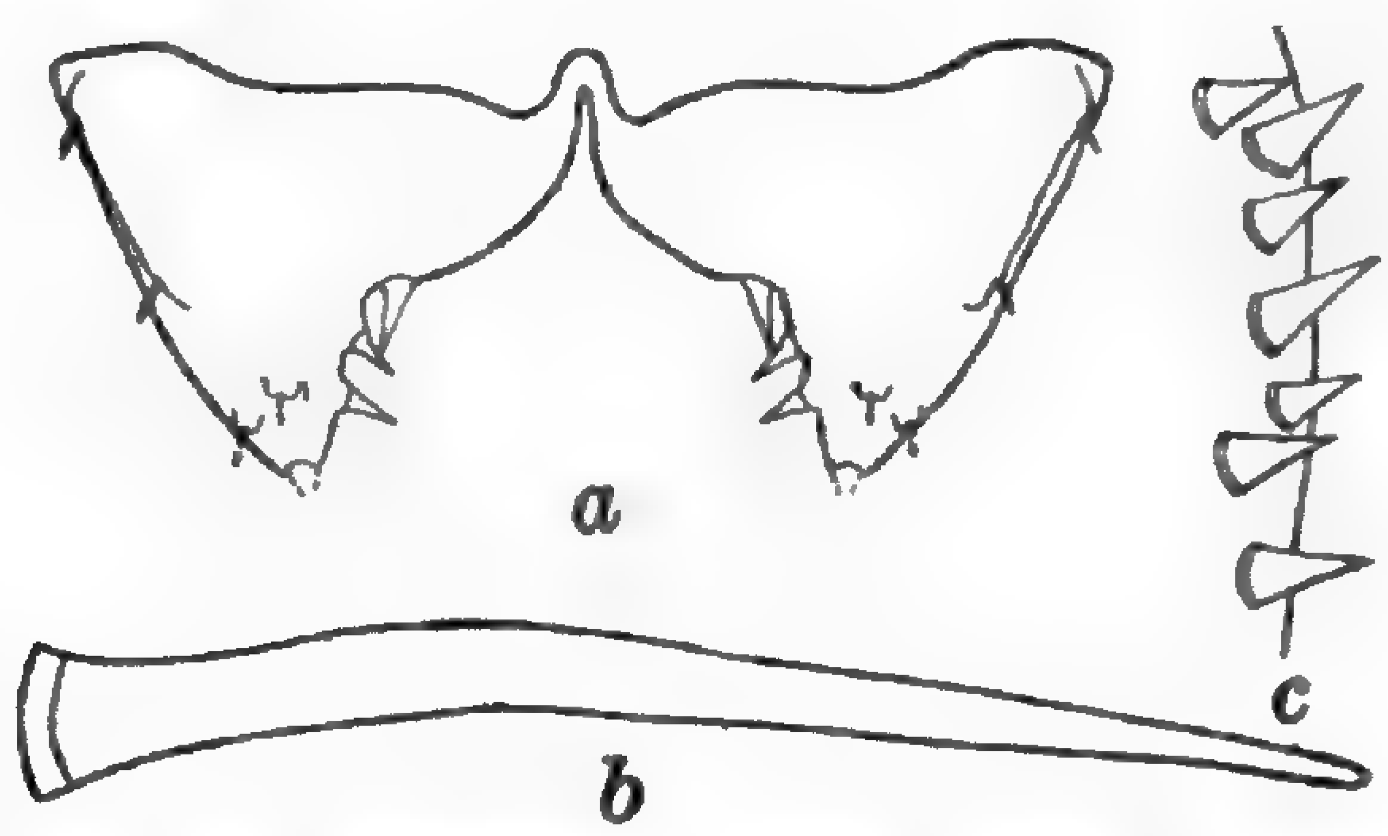


Fig. 30. *Ceroplastodes cajani* (Mask.), adult female; *a*, anal plates, × 165; *b*, spiracular spine, × 335; *c*, marginal spines, × 335.

## Genus COCCUS Linnæus

This genus, as used here, agrees with the use in the Fernald Catalogue and consequently takes in a number of the species described by English entomologists under *Lecanium*. Four species, one of which is believed to be confined to the Philippines, have been collected in the Islands.

*Key to the Philippine species of Coccus.*

$a^1$. Cephalolateral margin of anal plates distinctly much longer than caudolateral; body more or less distinctly triangular.

$b^1$. Marginal spines distinctly shorter than smallest spiracular spines; anal plates extremely elongate; with a fringe of ovisac in adult female ........................................ **Protopulvinaria longivalvata** Green.

[12] Coccidae of Ceylon, pt. 4 (1909) 285.

$b^2$. Marginal spines distinctly longer than the smallest spiracular spines; anal plates less elongate; without traces of an ovisac at maturity.

$c^1$. With a heavy median band of very minute pores running cephalad from the anal plates, this with some lateral arms; with small circular pores more or less definitely arranged on the dorsum. **Coccus diversipes** Ckll.

$c^2$. Without such a band of minute pores; dorsally with fairly numerous medium-sized oval pores with rather definite arrangement. **Coccus mangiferæ** (Green).

$a^2$. Cephalolateral margin of anal plates at most very slightly longer than caudolateral margin; body more or less oval.

$d^1$. Marginal setæ small, short, prominently dilated and frayed at apices; antennæ normally 7-segmented.... **Coccus viridis** (Green).

$d^2$. Marginal setæ much longer, slender, entire or rarely very faintly frayed at apices; antennæ normally 8-segmented. **Coccus elongatus** (Sign.).

**Coccus diversipes** Ckll.

*Coccus diversipes* Ckll., ROBINSON, Philip. Journ. Sci. § D 12 (1917) 15.

This species does not appear to have been collected since the original lot of material from which it was described was obtained. Some figures are given in order to give a more elaborate idea of its characteristics than is to be obtained from the original description. As will be noted from these, it is quite closely related to the following species in many ways, but differs in the relation and character of the marginal and spiracular spines, as well as as in having the band of very numerous, minute dorsal pores.

**Coccus mangiferæ** (Green).

*Lecanium mangiferæ* GREEN, Ent. Month. Mag. (1889) 249; Cocc. Ceylon, pt. 3 (1904) 216.

This species is represented by a single lot of material collected at Paete, Laguna Province, on *Cocos nucifera* (coll. *McGregor*). The microscopic characters of the species as illustrated are quite distinctive.

**Coccus viridis** (Green).

*Lecanium viride* GREEN, Ent. Month. Mag. (1889) 284; Cocc. Ceylon, pt. 3 (1904) 216.

*Coccus viridis* (Green) ROBINSON, Philip. Journ. Sci. § D 12 (1917) 16.

While this is apparently a widespread tropical species, it has so far been collected only rarely in the Philippines. I have examined the following material:

LUZON, Manila, on *Citrus* sp. (coll. *Banks 10201*): Bataan

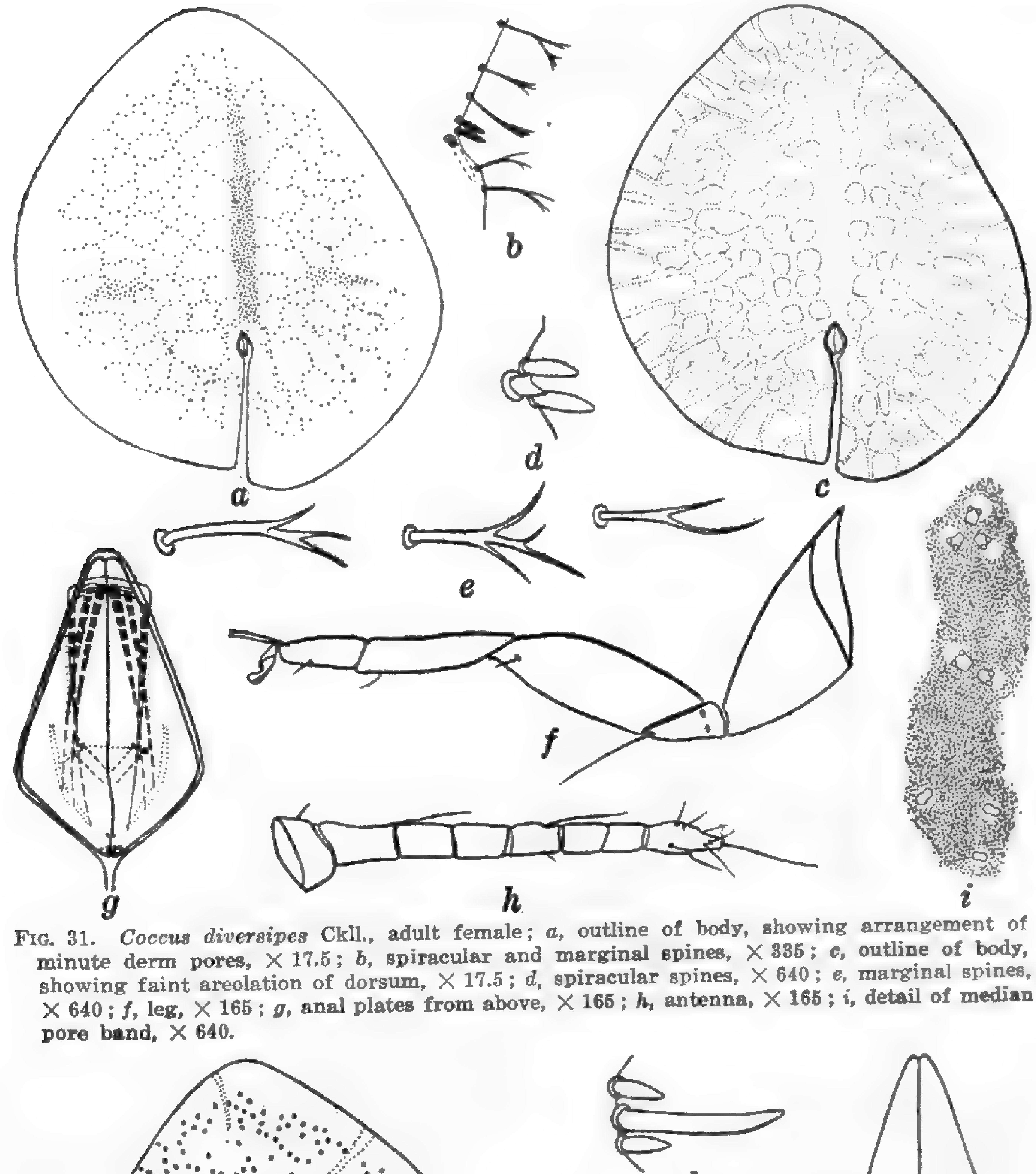


FIG. 31. *Coccus diversipes* Ckll., adult female; *a*, outline of body, showing arrangement of minute derm pores, × 17.5; *b*, spiracular and marginal spines, × 335; *c*, outline of body, showing faint areolation of dorsum, × 17.5; *d*, spiracular spines, × 640; *e*, marginal spines, × 640; *f*, leg, × 165; *g*, anal plates from above, × 165; *h*, antenna, × 165; *i*, detail of median pore band, × 640.

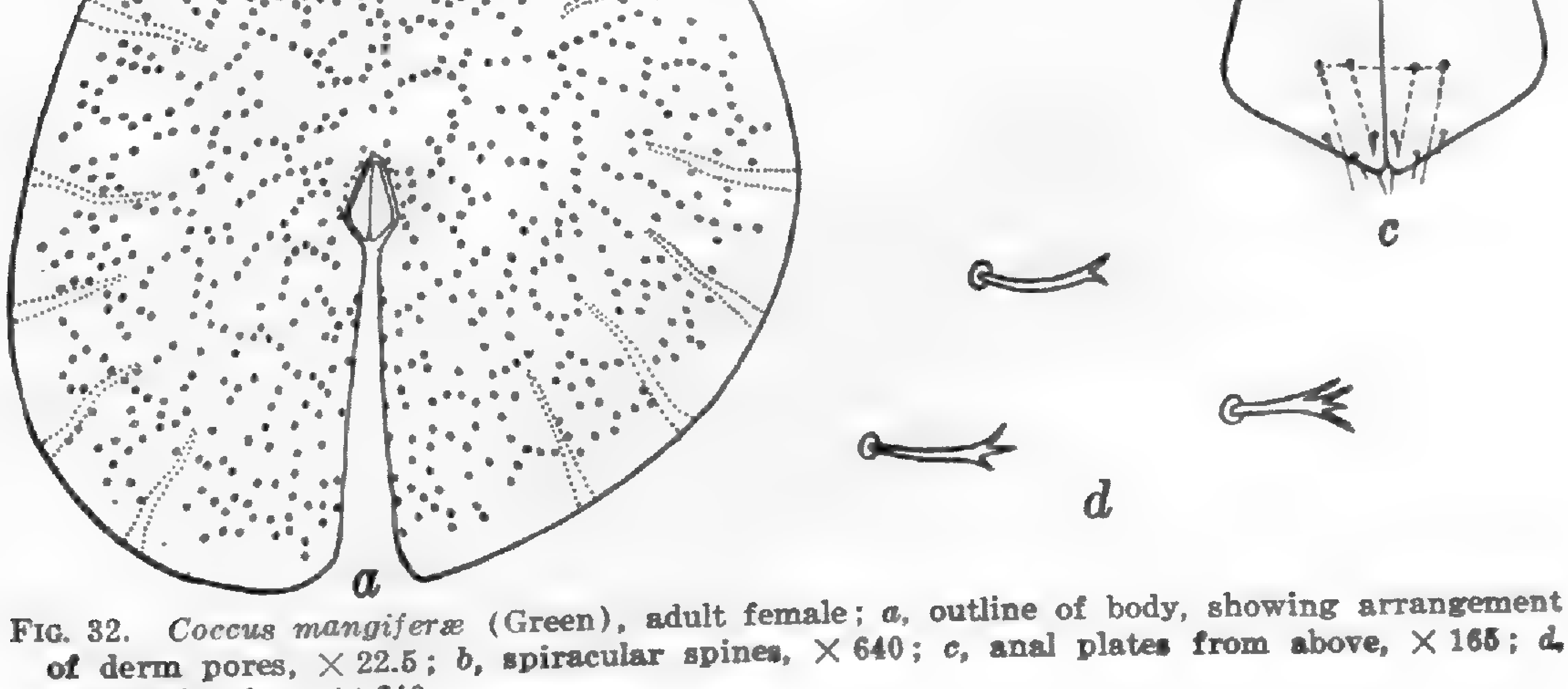


FIG. 32. *Coccus mangiferæ* (Green), adult female; *a*, outline of body, showing arrangement of derm pores, × 22.5; *b*, spiracular spines, × 640; *c*, anal plates from above, × 165; *d*, marginal spines, × 640.

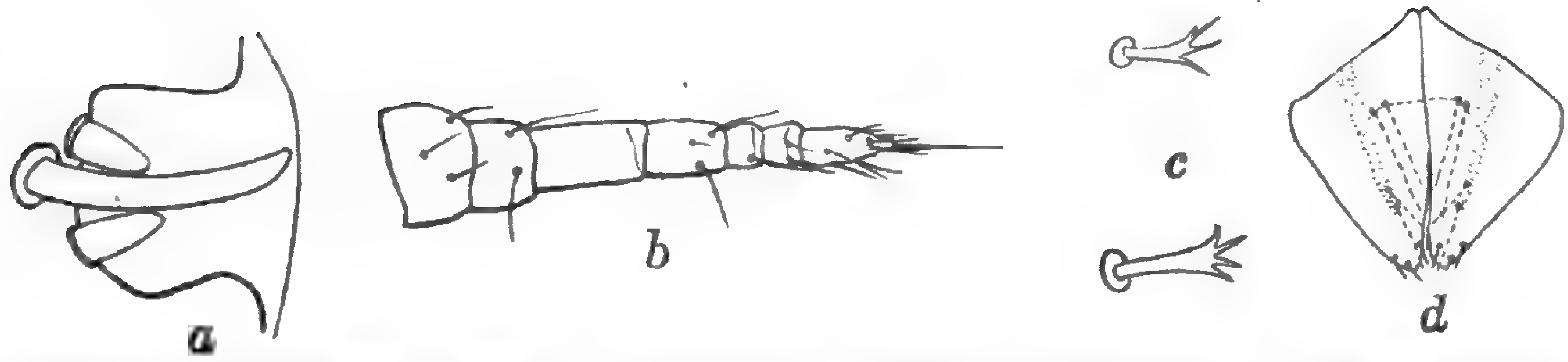


FIG. 33. *Coccus viridis* (Green), adult female; *a*, spiracular spines, × 640; *b*, antenna, × 165; *c*, marginal spines, × 640; *d*, anal plates from above, × 165.

Province, Lamao, on *Coffea* sp. (coll. *H. E. Stevens 18464*): Rizal Province, Pasay, on *Achras sapota* (coll. *McGregor*), in addition to that on which Miss Robinson's record is based. The species is bright green in life, in contrast to the following which is usually grayish or brownish.

**Coccus elongatus** (Sign.).

*Coccus elongatus* (Sign.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 15.

In addition to the records given by Miss Robinson, I have examined the following material:

LUZON: Manila, on mulberry (*20173*), on croton (*20155* and *20177*), and on orange (*Compere*), on *Gardenia florida* (*14581*) and *Codiaeum variegatum* (*10175*) (coll. *Banks*), on *Samanea saman* (coll. *McGregor*), on *Annona glabra* (coll. *Arce 2569*): Laguna Province, Los Baños, on *Annona muricata* (coll. *Banks 18458*).

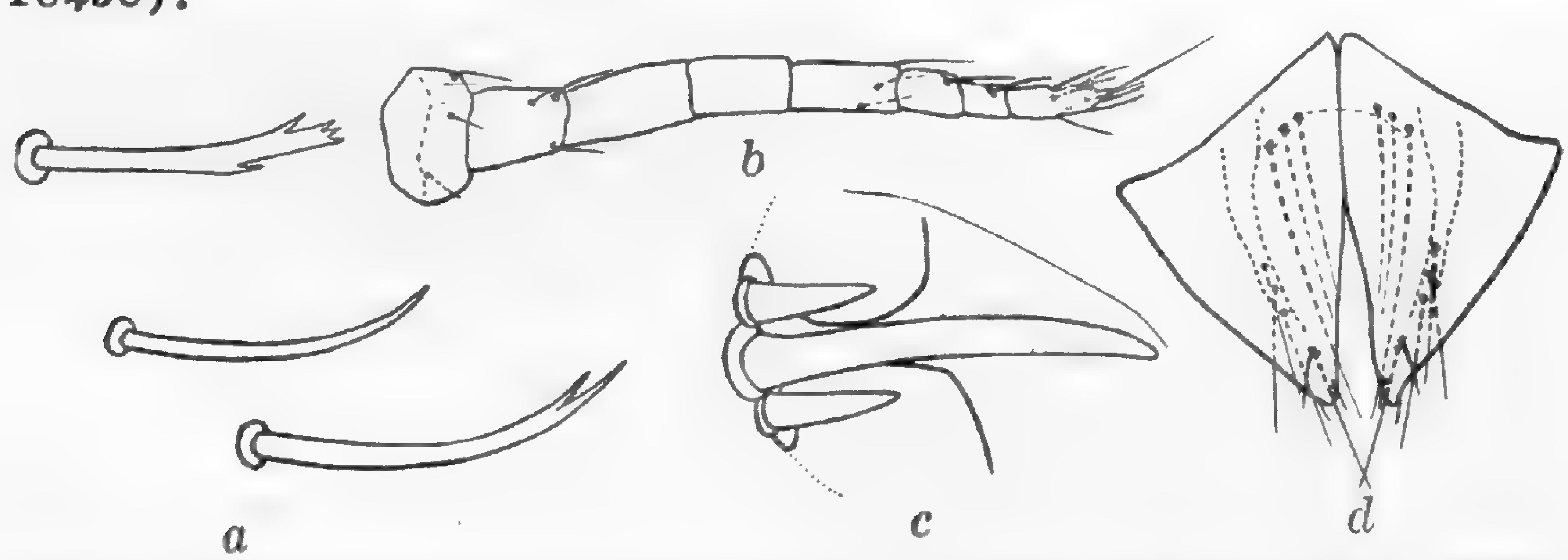


FIG. 34. *Coccus elongatus* (Sign.), adult female; *a*, marginal spines, × 640; *b*, antenna, × 165; *c*, spiracular spines, × 640; *d*, anal plates from above, × 165.

## Genus PLATYLECANIUM Cockerell and Robinson

This genus is represented in the Philippines by the type species. In the original description of the genus, the authors state "ventral surface of abdominal region with groups of pores arranged in a semicircle," etc., this being one of the primary characters of the genus. I have very carefully examined a portion of a specimen from the type material, all that has been available, and in addition specimens of *Platylecanium pseudexpansum* (Green), and of a third, undescribed species from Singapore, with the result that these pores appear to me to be quite certainly dorsal, instead of ventral, and the genus description should be changed accordingly. These groups of pores also occur in at least some species of the genus *Paralecanium.*

**Platylecanium cribrigerum** (Ckll. and Rob.).

*Platylecanium cribrigerum* (Ckll. and Rob.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 12, 13.

About a fifth of one specimen from the type material has been examined through the kindness of Professor Cockerell.

## Genus PARALECANIUM Cockerell

This genus is composed of medium-sized, flat, oval to circular species, which have the marginal hairs modified into broadly expanded and flattened flabellæ which usually overlap more or less. I have been unable certainly to differentiate *Paralecanium expansum* Green and *P. cocophyllæ* Banks, and have therefore made use of the comparative characters given by Banks in his description in preparing the following key:

*Key to the Philippine species of Paralecanium.*

$a^1$. Legs and antennæ well developed, the latter 7-segmented. **P. luzonicum** Ckll.

$a^2$. Legs wanting; antennæ at most indistinctly 4- or 5-segmented.

- $b^1$. Color pale yellow; marginal flabellæ broader in proportion to length and more narrowed at base; spiracular spines always three in each group; male puparium with seventeen plates. **P. cocophyllae** Banks.
- $b^2$. Color reddish brown; marginal flabellæ more nearly circular or long oval, at most very slightly narrowed at base; spiracular spines varying from three to nine in each group; male puparium with eighteen plates.......... **P. expansum quadratum** (Green).

**Paralecanium luzonicum** Ckll.

*Paralecanium luzonicum* Ckll., ROBINSON, Philip. Journ. Sci. § D 12 (1917) 12.

Through the kindness of Professor Cockerell, I have been able to examine a portion of the type material. This species does not appear to have been collected since the time it was described. It is easily separable from the other two known from the Phil-

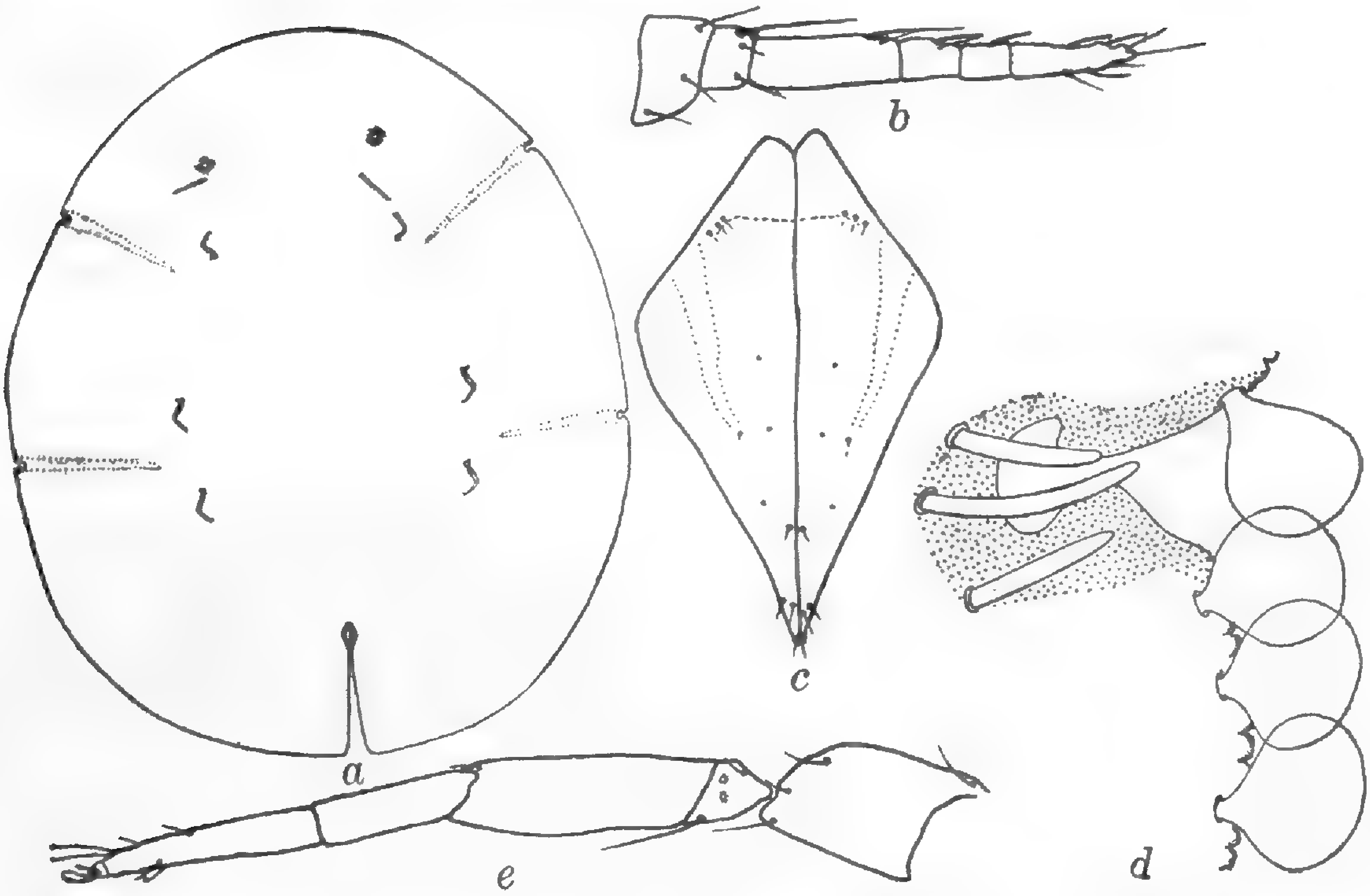


FIG. 35. *Paralecanium luzonicum* Ckll., adult female. *a*, outline of body, showing legs, antennæ, grooves opposite spiracles, etc., × 12; *b*, antenna, × 165; *c*, anal plates from above, × 165; *d*, spiracular and marginal spines, × 335; *e*, leg, × 165.

ippines, and also appears to be distinct from the numerous species with well-developed legs and antennæ described from Ceylon by Green in his Coccidae of Ceylon.

**Paralecanium cocophyllæ** Banks.

*Paralecanium cocophyllæ* Banks, ROBINSON, Philip. Journ. Sci. § D 12 (1917) 12.

**Paralecanium expansum quadratum** (Green). Plate 1, fig. 11.

*Lecanium expansum* var. *quadratum* GREEN, Cocc. Ceylon, pt. 3 (1904) 236.

Material from the Philippines which I have considered to be this species has been compared with specimens from Ceylon, sent by Mr. Green. While a number of variations from the normal characters found in typical *P. expansum* from Ceylon have been noted, I have been unable to conclude that the Philippine specimens are distinct from *expansum* var. *quadratum*, and place them under this name for the present without attempting to decide whether or not var. *quadratum* should be considered to be specifically distinct from true *expansum*. The Philippine material that has been examined appears to be intermediate between typical *expansum* and *cocophyllæ* as described by Banks.

In the collections listed below, the shape and the size of the body agree with *expansum;* the marginal flabellæ are more rounded and not quite so close together, so that the overlapping seems less pronounced; the spiracular spines occur normally in groups of three, but one clear example of five in a group was noted; the large derm pores are arranged approximately as in *ex-*

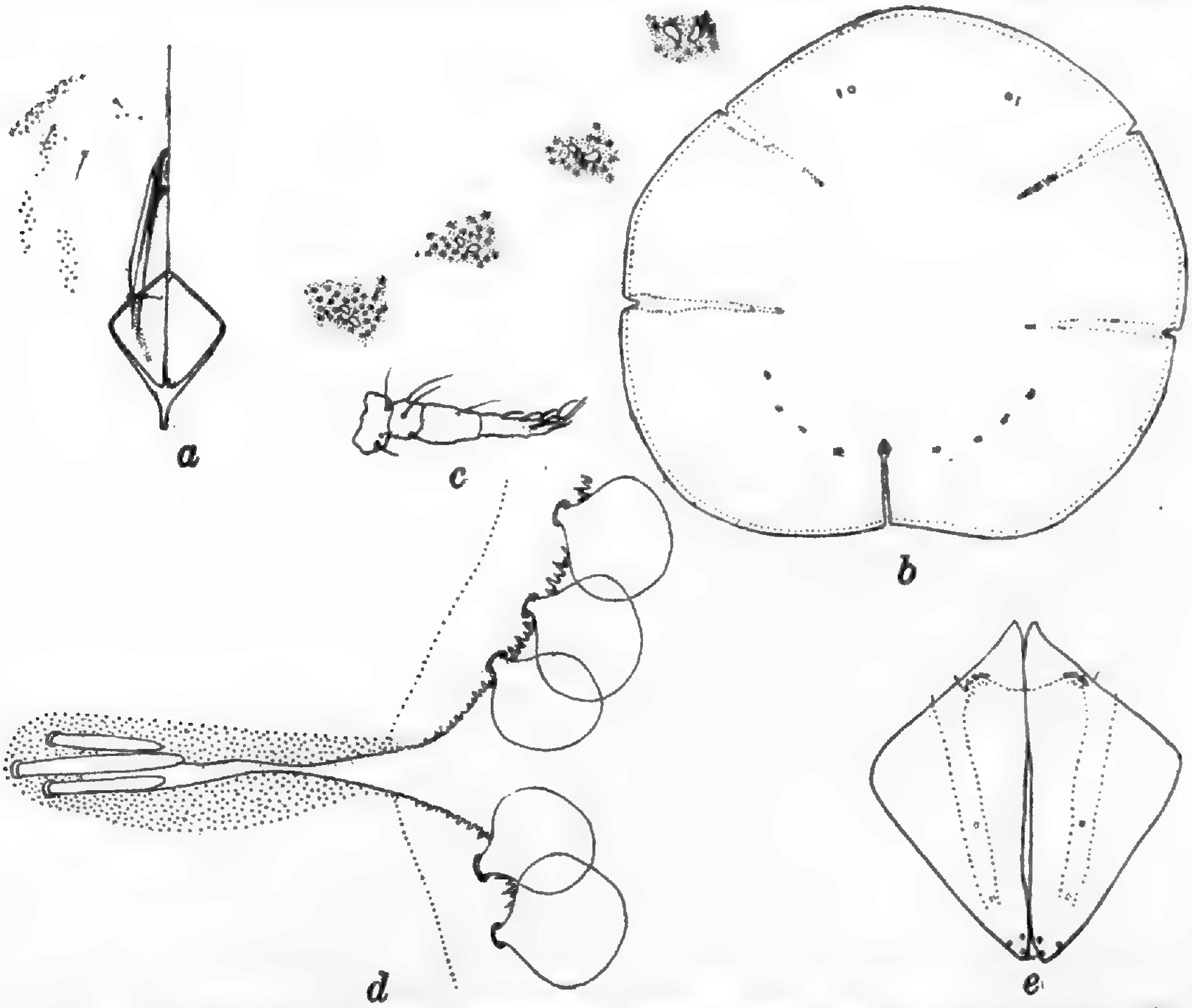


FIG. 36. *Paralecanium expansum quadratum* (Green), adult female; *a*, anal plate region, ventral and dorsal, showing pores and cribriform plates, × 57.5; *b*, outline of body, × 12; *c*, antenna, × 165; *d*, spiracular and marginal spines, × 335; *e*, anal plates from above, × 165.

*pansum,* but the grouped pores or "cribriform plates" running forward and outward from the anal plates occur in four groups on each side of the plates, instead of in three, thus resembling *cocophyllæ,* while the anal plates are stouter than in typical *expansum,* thus corresponding to var. *quadratum,* and also resembling *cocophyllæ* more closely. The color of the specimens examined is a dull yellow or light brown, thus suggesting a mean between that given by Green for *expansum* and that given by Banks for *cocophyllæ,* although small differences may be accounted for in a number of ways. The following material has been examined:

LUZON, Manila, on bark of ylang ylang tree (coll. *Compere 20146*): Laguna Province, Paete, on *Diplodiscus paniculatus* (coll. *McGregor*).

## Genus SAISSETIA Desplanches

Three very common and widespread species, members of this genus, have been reported from the Philippine Islands, and another, apparently new, is described herewith. The usually convex to hemispherical shape, and the development of a heavily chitinized and areolated dorsal derm, are the characteristics at present accepted to isolate this genus.

*Key to the Philippine species of Saissetia.*

$a^1$. With only about ten to twelve submarginal gland tubercles around the body margin; marginal setæ more or less flattened and broadened at apices; species larger, oval or hemispherical, with or without ridges.

- $b^1$. Female without ridges of any sort in the adult stage, either strongly hemispherical or much less convex and oval.
  - $c^1$. Female strongly convex, hemispherical; color usually yellow brown; derm areas oval and often separated by more than their own diameter ........ S. hemisphaerica (Targ.).
  - $c^2$. Female at most only moderately convex; nearly black; derm areas large, closely approximated, polygonal........ S. nigra (Nietn.).
- $b^2$. Female strongly convex; very dark brown or blackish brown; dorsum with distinct ridges in adult, these forming a transverse H-shaped mark........ S. oleae (Bern.).

$a^2$. With more than forty submarginal gland tubercles around the body margin; marginal setæ tapering, acute at apices; species small, irregularly triangular, not very convex, with three dorsal ridges radiating from the center to the corners of the body........ S. triangularum sp. nov.

**Saissetia hemisphaerica (Targ.).**

*Saissetia hemisphærica* (Targ.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 14.

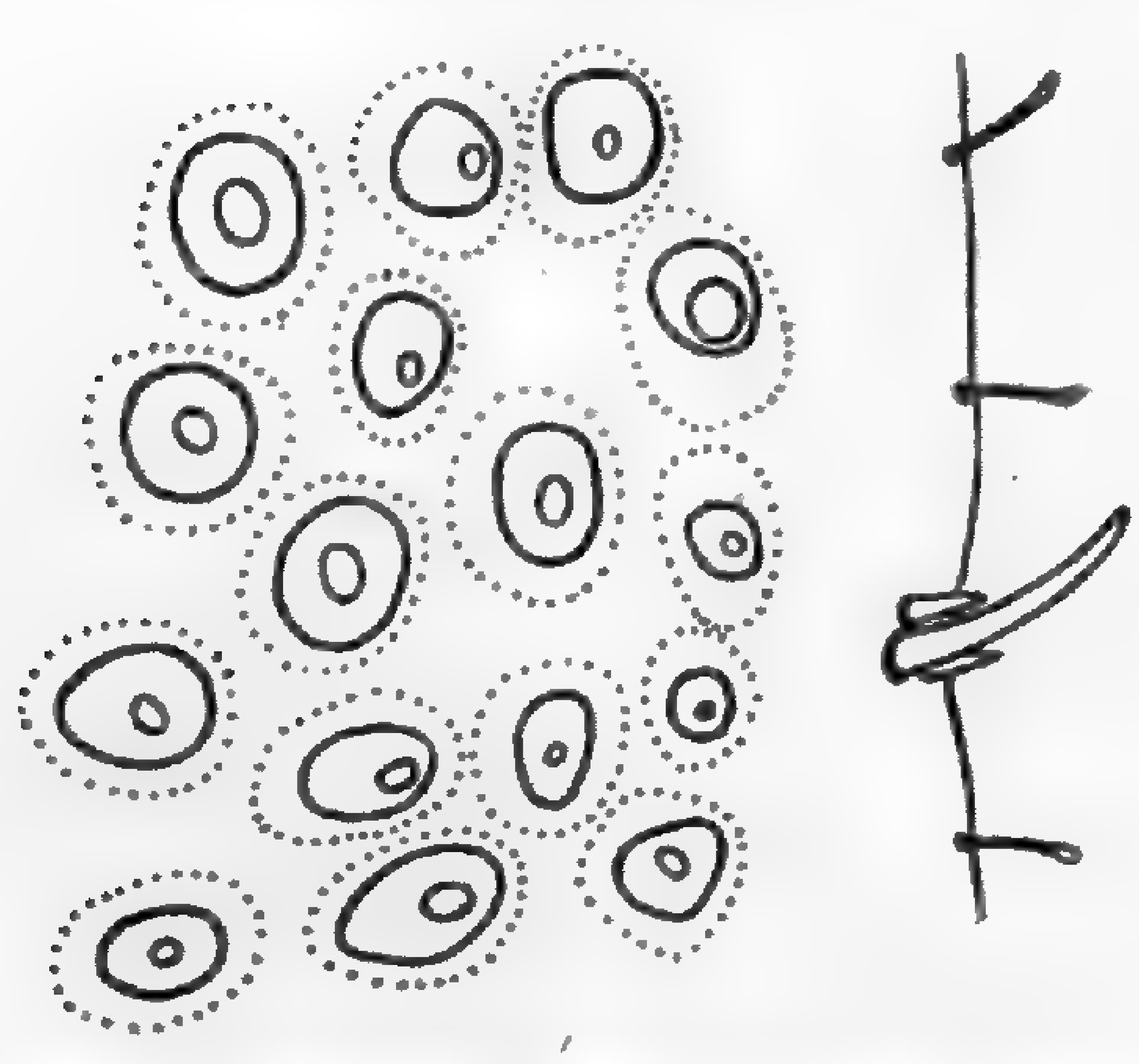

FIG. 37. *Saissetia hemisphaerica* (Targ.), adult female, showing derm areolation, marginal and spiracular spines, × 165.

To the records given by Miss Robinson, the following may be added:

LUZON, Manila, on *Chrysophyllum cainito* (*10074*), on unknown host (*10218*), on *Thunbergia grandiflora* (*16666*), on *Cycas revoluta* (*18463*) all collected by *Banks*, on ornamental vine (coll. *Baker 10100*): Rizal Province, Pasay, on *Coffea arabica* and *Tabernaemontana pandacaqui* (coll. *McGregor*).

**Saissetia nigra** (Nietn.).

*Saissetia nigra* (Nietn.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 14.

Specimens of this species have been examined from the following localities:

LUZON, Manila, on *Canna indica* (*10169*), on *Manihot utilissima* (*10174*), on *Erythrina indica* (*10209*), all collected by *Banks:* Batangas Province, Nasugbu, on *Morus alba* (coll. *Banks 10198*).

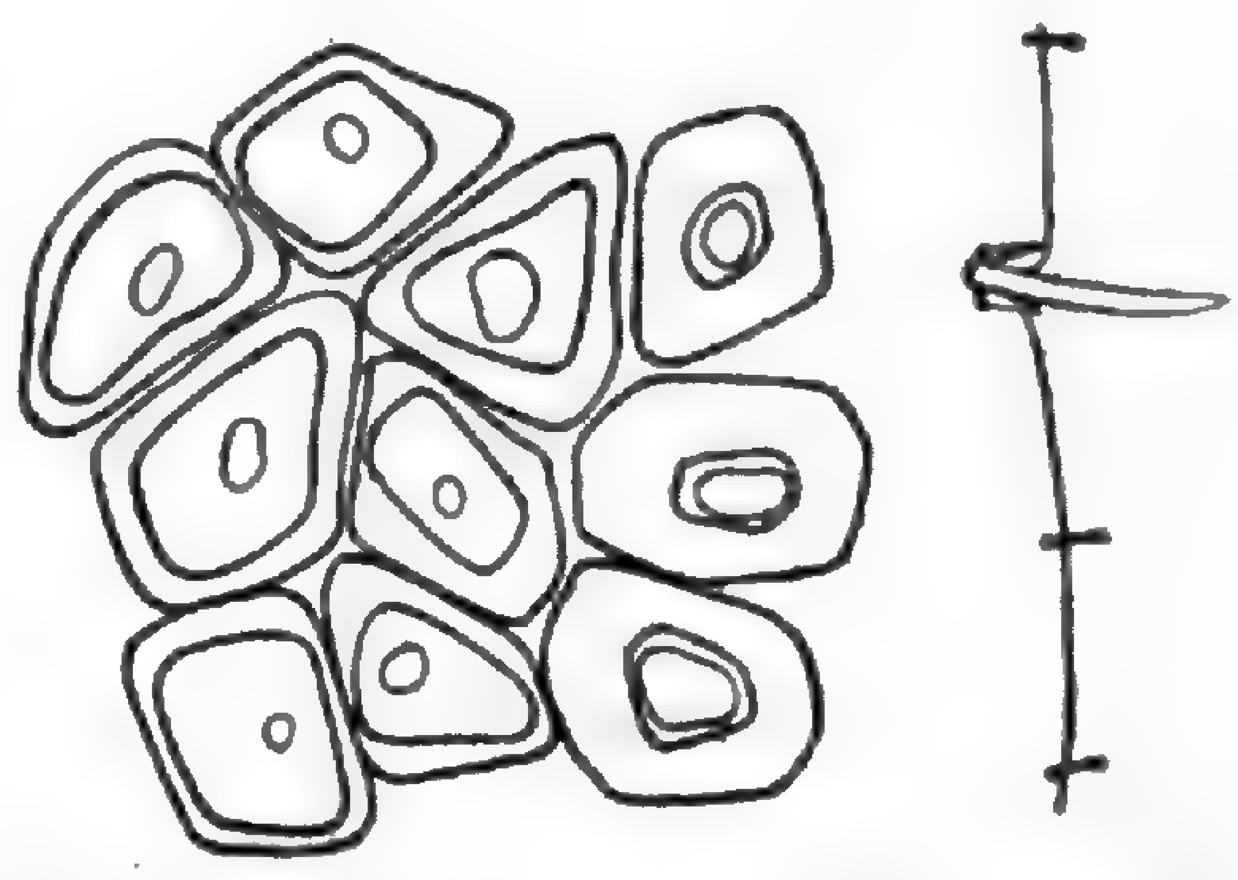

FIG. 38. *Saissetia nigra* (Nietn.), adult female, showing derm areolation, marginal and spiracular spines, × 165.

**Saissetia oleae** (Bern.).

*Saissetia oleæ* (Bern.), ROBINSON, Philip. Journ. Sci. § D 12 (1917) 13.

I have seen no specimens of this species from the Philippines, and the accompanying drawing has been made from specimens from the United States.

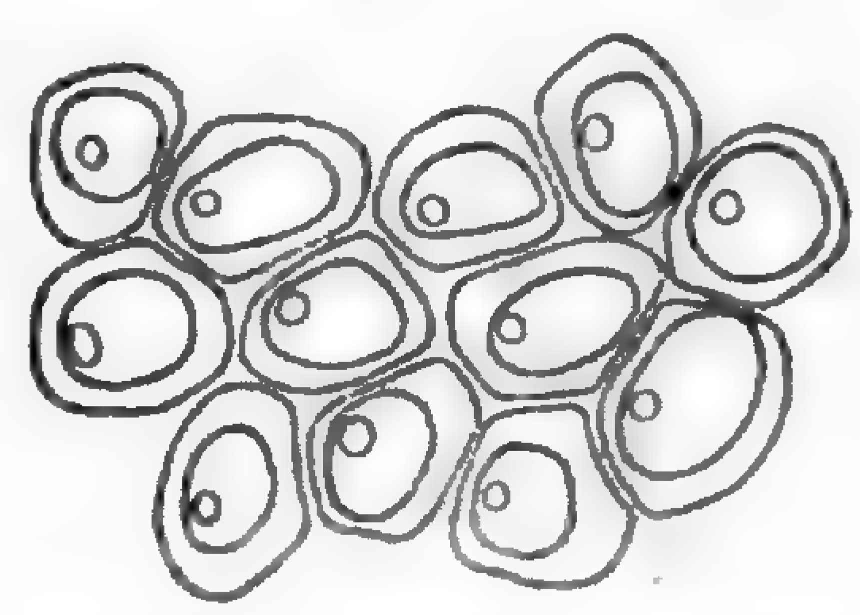

FIG. 39. *Saissetia oleae* (Bern.), adult female, derm areolation, × 165.

**Saissetia triangularum** sp. nov.

*Adult female.*—Occurring on the undersides of the leaves of the host; about 1.5 millimeters long by 2 millimeters or less wide, typically very broad-triangular, with both sides and angles rounded, widest far behind the middle, but the shape quite variable and sometimes asymmetrical; slightly convex, but with three broad and usually prominent ridges meeting at about the center of the body and radiating to the anterior and the two posterior lateral corners of the body; anterior corner more or less indented; spiracular spine regions very indistinctly indented; a light reddish brown in color in the dried state.

*Body of female.*—Gradually clearing when boiled in caustic potash, the marginal areas first, finally becoming almost wholly transparent, the derm areolations not extending to the body margin, of the same type as those found in *S. nigra,* but much smaller, more delicate and even more irregular in size and shape than in that species; antennæ 6-segmented, the third much the longest, about as long as the following three combined, the measurements in microns as follows:

172178——5

| I | II | III | IV | V | VI |
|---|---|---|---|---|---|
| 25 | 25 | 89 | 21.4 | 25 | 53.5 |
| 25 | 26 | 85.7 | 39 | | 50 |
| 25 | 32 | 93 | 21.4 | 19 | 43 |
| 23 | 25 | 82 | 21.4 | 18 | 39 |
| 25 | 28.5 | 91 | 25 | 21.4 | 43.5 |
| 26.5 | 35.7 | 93 | 26.5 | 25 | 50 |
| 25 | 32 | 96 | 22 | 23 | 50 |
| 25 | 32 | 96 | 24 | 21.4 | 46.5 |
| 21.4 | 28.5 | 85.7 | 21.4 | 24 | 46.5 |

Legs not unusual for the genus, tibia and tarsus approximately equal in length; spiracles slender and somewhat cylindrical in middle, broadly expanded at each end; marginal setæ numerous, long, slender, bluntly pointed at apices, spaced irregularly, but averaging about their own length apart, averaging about 32 $\mu$ in length, posterior spines longer, those on each side of the apex of anal cleft as much as 100 $\mu$ long; spiracular spines in groups of three, the middle a little more than twice the length of either of the other two, the latter often slightly unequal in length, all stout, the smaller tapering uniformly to a rounded apex, the larger tapering distinctly only near the apex; dorsally with some widely scattered tiny peglike tapering spines, apparently arranged in curving longitudinal rows; ventrally with a submarginal row of tiny setæ and with a few others, similar, scattered over the under surface of the body, with three pairs of long, slender setæ just anterior to the anal lobes and another pair, unequal in length, inside each antennal base; dorsally with an abundant supply of minute, short-tubular gland ducts, each with a slender, threadlike continuation of the bottom, with a cluster of circular disks, presumably glandular, anterior to the anal plates, and with a median cluster of bilocular and circular pores nearly opposite or a little behind the middle legs; ventrally with a single to triple line of circular quinquelocular pores between the spiracles and the corresponding spine groups, and with larger multilocular pores, with nine or ten loculi and large open centers, in a cluster around the anal plates; submarginal gland tubercles very numerous, varying from forty-two to forty-eight in the specimens examined, often with an uneven number on each body half, and sometimes with two, one within the other, at the same point on the margin; anal plates in normal position, the cleft short, triangular, nearly twice as long as wide, the posterolateral face distinctly longer than the anterolateral, under compression appearing proportionately broader, with the

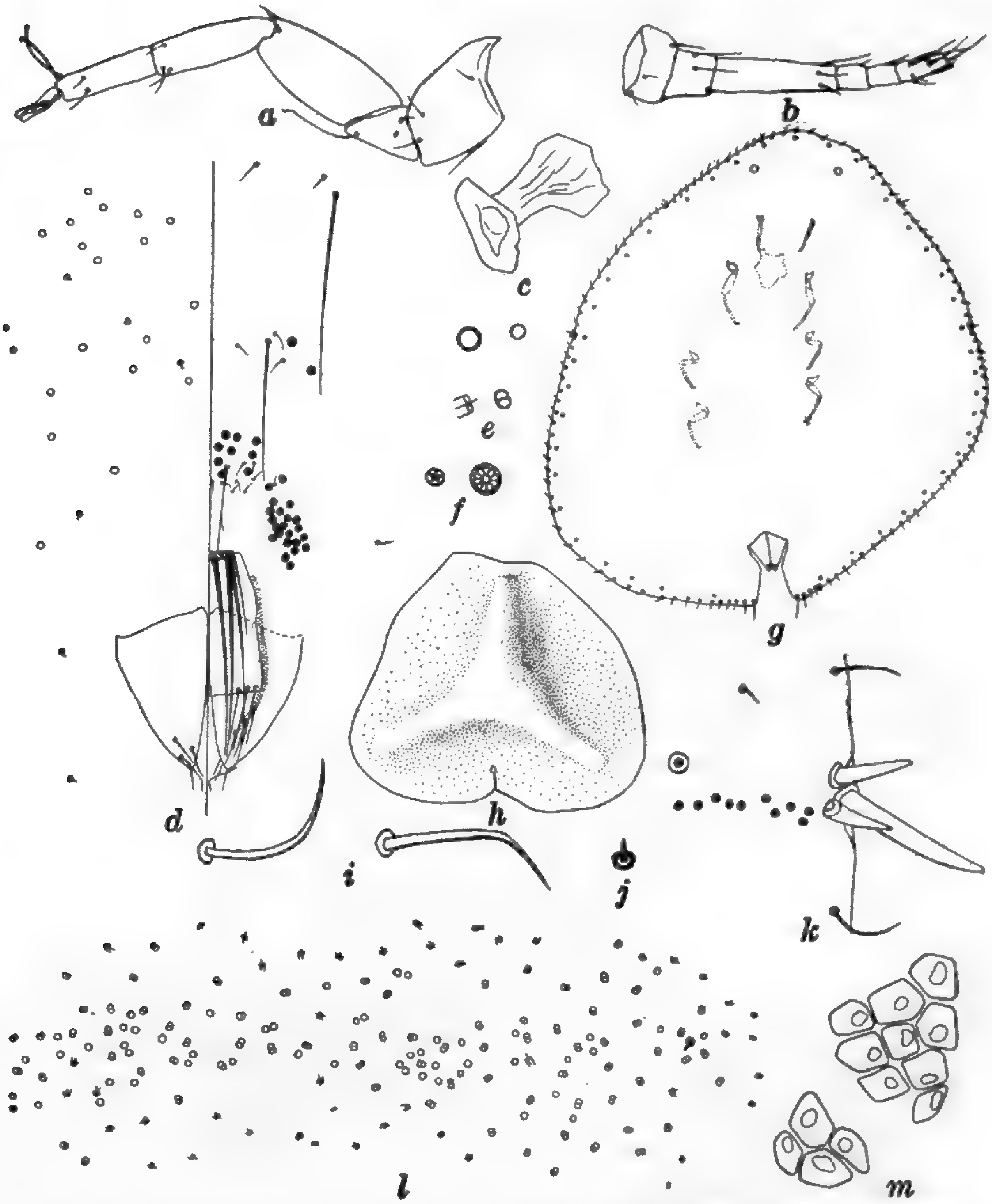


FIG. 40. *Saissetia triangularum* sp. nov., adult female; *a*, leg, × 165; *b*, antenna, × 165; *c*, spiracle, × 335; *d*, anal plate region, dorsal to left, ventral to right, × 165; *e*, some types of dorsal gland pores, × 640; *f*, ventral multilocular pores, smaller from spiracular band, larger from near anal ring, × 640; *g*, outline of body, showing position and relation of various structures, × 29; *h*, outline of body, showing shape and the three central ridges, × 12; *i*, marginal spines, × 640; *j*, dorsal body spine, × 640; *k*, spiracular and marginal spines, × 335; *l*, dorsal median transverse band of double and circular pores, × 335; *m*, derm areolation, × 165.

outer angle sharp and rectangular; with one apical and three dorsal setæ, all apparently easily deciduous from the plates, with three larger setæ on the ventral ridge, with two or three fringed setæ on each side, the latter number apparently commoner; no hypopygial setæ noted; anal ring with eight relatively stout setæ, one pair of which is much smaller than the others, small, heavy, with a double row of pores on each half.

This species has been described from eight specimens mounted on slides. No satisfactory material of any other stage has been obtainable. The specimens were collected at Paete, Laguna Province, Luzon, on *Cocos nucifera*, May 22, 1917 (*McGregor*). The types are in the United States National collection of Coccidæ.

The small size of this species, its peculiar ridging, and the very numerous submarginal gland tubercles seem to be characteristic, and to separate it from any other member of the genus known to me.

# ILLUSTRATIONS

## Plate 1

[All figures on the plate are enlarged 2.5 times.]

Fig. 1. *Icerya aegyptiaca* (Dougl.), adult female.
2. *Icerya seychellarum* (Westw.), adult female.
3. *Drosicha townsendi* (Ckll.), adult female from beneath, before beginning of oviposition.
4. *Tachardia minuta* sp. nov., adult female and young on midrib of leaf.
5. *Rhizococcus philippinensis* sp. nov., adult female and male puparia.
6. *Antonina zonata* Green, adult female in bamboo node.
7. *Pseudococcus virgatus* (Ckll.), adult female.
8. *Pseudococcus filamentosus* (Ckll.), sacs of adult female.
9. *Pulvinaria polygonata* Ckll., adult females.
10. *Vinsonia stellifera* (Westw.), adult females.
11. *Paralecanium expansum quadratum* (Green), adult females, dorsal and ventral surfaces.

### TEXT FIGURES

Fig. 1. *Icerya jacobsoni* Green, adult female.
2. *Icerya purchasi* Mask., adult female.
3. *Icerya seychellarum* (Westw.), adult female.
4. *Icerya aegyptiaca* (Dougl.), adult female.
5. *Lophococcus convexus* sp. nov., adult female.
6. *Lophococcus convexus* sp. nov., adult female.
7. *Drosicha townsendi* (Ckll.), adult female.
8. *Asterolecanium bambusæ* (Bdv.) adult female.
9. *Rhizococcus philippinensis* sp. nov., larva and adult female.
10. *Puto spinosus* (Rob.), adult female.
11. *Synacanthococcus bispinosus* g. et sp. nov., adult female.
12. *Phenacoccus hirsutus* Green, adult female.
13. *Pseudococcus virgatus* (Ckll.), adult female.
14. *Pseudococcus virgatus* (Ckll.), adult female.
15. *Pseudococcus sacchari* (Ckll.), adult female.
16. *Pseudococcus filamentosus* (Ckll.), adult female.
17. *Pseudococcus bromeliae* (Bouché), adult female.
18. *Pseudococcus lilacinus* Ckll., adult female.
19. *Antonina zonata* Green, adult female.
20. *Tachardia fici* Green, adult female.
21. *Tachardia minuta* sp. nov., larva and adult female.
22. *Pulvinaria thespesiæ* Green, adult female.
23. *Pulvinaria polygonata* Ckll., adult female.
24. *Pulvinaria tyleri* Ckll., adult female.
25. *Pulvinaria psidii* Mask., adult female.

FIG. 26. *Protopulvinaria longivalvata* Green, adult female.
27. *Vinsonia stellifera* (Westw.), adult female.
28. *Ceroplastes ceriferus* (And.), adult female.
29. *Ceroplastes rubens* Mask., adult female.
30. *Ceroplastodes cajani* (Mask.), adult female.
31. *Coccus diversipes* Ckll., adult female.
32. *Coccus mangiferæ* (Green), adult female.
33. *Coccus viridis* (Green), adult female.
34. *Coccus elongatus* (Sign.), adult female.
35. *Paralecanium luzonicum* Ckll., adult female.
36. *Paralecanium expansum quadratum* (Green), adult female.
37. *Saissetia hemisphaerica* (Targ.), adult female.
38. *Saissetia nigra* (Nietn.), adult female.
39. *Saissetia oleae* (Bern.), adult female.
40. *Saissetia triangularum* sp. nov., adult female.

# SOME THYSANOPTERA FROM THE PHILIPPINE ISLANDS

By H. Karny

*Of Vienna, Austria*

FOUR TEXT FIGURES

In this paper, I am publishing a short notice of several Thysanoptera, which Prof. Charles Fuller Baker collected in the Philippine Islands and kindly sent to me for determination, several years ago. In this collection there are two very interesting specimens, each representing a new species; all the other specimens belong to *Dinothrips sumatrensis* Bagnall, a common and widely distributed bark-inhabiting species of the Indo-Malayan Archipelago.

**Dinothrips sumatrensis** Bagnall. Fig. 1.

This species is represented in the material before me by twenty-five females and seven males from Butuan, Mindanao (leg. *Baker*), one female from Los Baños, and one male from Mount Banahao, all Philippine localities. I have it in my collection also from the type locality, Nias Island, Sumatra, owing to the kindness of Mr. Bagnall; further from Java (leg. *Docters van Leeuwen-Reijnvaan,* under bark), from Perak (ex coll. *Staudinger*) and from Ceylon (*Horn* 1899). From Ceylon this species was described by Schmutz (1913) as *Dinothrips furcifer;* but in the original description of *furcifer* I could not find any distinction from the true *sumatrensis,* and an examination of the type specimen of Schmutz's species in the Vienna Museum—for which I am indebted to the kindnes of Mr. Handlirsch—has made it clear to me that *furcifer* is to be regarded as a synonym of *sumatrensis.* This species is further known from Bengal, Tonkin, and Burma, and through the whole Malayan Archipelago as far as New Guinea.

The coloration of the antenna is very characteristic; it is wholly coal black, only the third joint paler, yellowish, at the end blackish. One of the females in the material before me has the left antenna anomalous. Not only the third joint, but also all following are pale yellowish brown. The antenna seems to be seven-jointed, but a closer examination shows that on the under surface of the first joint two additional subglobular joints are laterally inserted, forming a short, thick, styliform process (fig. 1). These two additional joints are blackish and have a few setiform hairs. The right antenna of this specimen has the normal form.

The whole surface of the fore femur is covered with a number of spine-bearing pits, as in certain Idolothripidæ. The fore tarsus is armed with a strong tooth, which in the male is subcylindrical and slender, about as long as the tarsus is broad; in the female, triangular and hardly as long as half of the tarsal breadth. The intermediate femora bear before the middle—as Bagnall has already pointed out—a forwardly directed tubercle; but it is very variable in form and size and seems in some specimens to be entirely absent. The anterior angles of

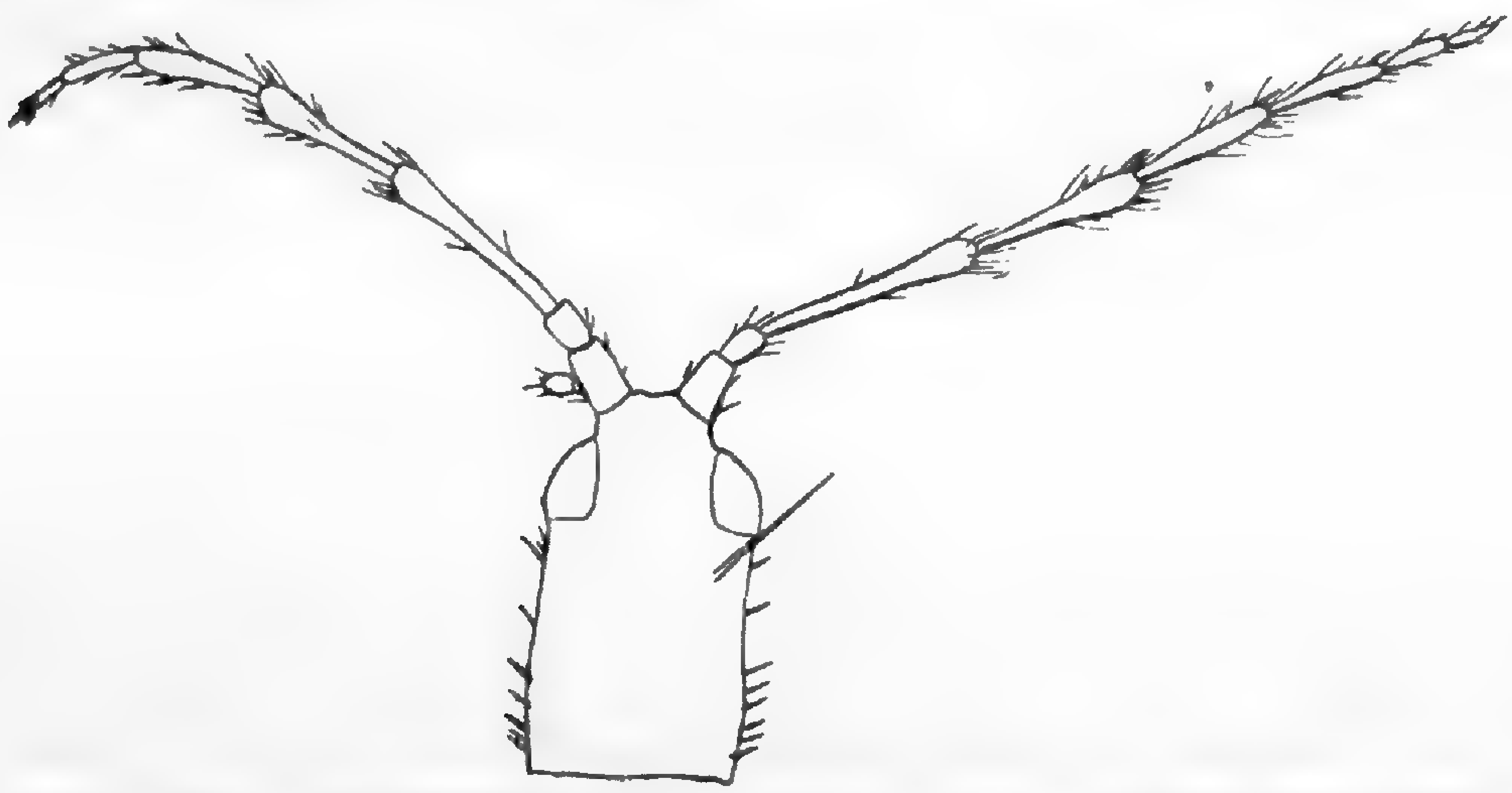

FIG. 1. Head of *Dinothrips sumatrensis*, female, with anomalous left antenna.

the mesonotum are in the male armed with a peculiar bifurcate appendage; in some females, with a small tooth, but usually without it and entirely unarmed.

The coloration of the fore wings is very characteristic. There is near the base close to the fore margin a cloudy dark spot and after it a median, longitudinal, dark brown stripe, which is dilated in the middle of the wing to a smoky, distally evanescent patch. On the hind margin there are about seventy duplicated ciliæ.

**Dinothrips monodon** sp. nov. Fig. 2.

Dark brownish black. Coloration of antennæ as in *sumatrensis*. Head about twice as long as broad, its greatest width in the basal third. Mouth cone rounded at the end, reaching about half the length of prosternum. Postocular bristles and cheek spines well defined. Antennal joints of the same form as in *sumatrensis*, each bearing some strong bristles near the middle and before the apex; the two basal and the two apical joints without sense cones; third, fourth, and fifth with one on each side; sixth with only one at the inner margin.

Prothorax transverse, dilated toward the base. Bristles and spines of prothorax and fore coxæ as in *sumatrensis*. Surface of all femora wholly covered with paler, spine-bearing pits. Fore femora strongly incrassate in the male; fore tarsus of the male armed with a very large, somewhat inwardly directed tooth, which is about as long as the tarsus is wide and at base two or more times wider than in *sumatrensis*. Intermediate femora without a conspicuous tubercle.

Mesothoracic appendages not bifurcate, lanceolate, with a sharp outwardly directed tip (fig. 2); on the anterior margin with two, on the posterior with one blunt tooth. Coloration of wings as in *sumatrensis;* hind margin of fore wings with about seventy pairs of fringe hairs. Chætotaxy of abdomen and form of tube as in *sumatrensis*.

*Measurements of Dinothrips monodon sp. nov., male.*

| | Length. | Width. |
|---|---|---|
| Antennæ: | *mm.* | *mm.* |
| First joint | 0.11 | 0.08 |
| Second joint | 0. | 0.06 |
| Third joint | 0.45 | 0.07 |
| Fourth joint | 0.35 | 0.07 |
| Fifth joint | 0.29 | 0.06 |
| Sixth joint | 0.20 | 0.05 |
| Seventh joint | 0.12 | 0.025 |
| Eighth joint | 0.08 | 0.015 |
| Total length of antennæ | 1.7 | ------ |
| Head | 0.83 | 0.42 |
| Prothorax | 0.6 | [a] 1.05 |
| Fore femora | 0.85 | 0.4 |
| Fore tibiæ, including tarsi | 0.9 | 0.17 |
| Pterothorax | 1.1 | 1.4 |
| Middle femora | 0.85 | 0.2 |
| Middle tibiæ, including tarsi | 0.95 | 0.12 |
| Hind femora | 1.0 | 0.18 |
| Hind tibiæ, including tarsi | 1.15 | 0.1 |
| Wing, without fringe | 3.5 | ------ |
| Abdomen | 4.8 | 1.25 |
| Tube | 0.75 | ------ |
| Tube, at base | ------ | 0.2 |
| Tube, at apex | ------ | 0.08 |
| Total length of insect | 7.5 | ------ |

[a] Across fore coxæ.

FIG. 2. Mesothoracic appendages of *Dinothrips monodon*, male.

This species is to be distinguished from *sumatrensis* by the form of mesothoracic appendages and of the fore tarsal tooth in the male; but I could not find any other differences, and I am therefore unable to distinguish the females. The description of *affinis* Bagnall from Sarawak I have not yet seen.

MINDANAO, Butuan (leg. *Baker*), 1 male.

**Dicaiothrips bakeri** sp. nov. Figs. 3 and 4.

Wholly brownish black, fore tibiæ and tarsi paler, yellowish brown, darker, blackish brown along outer and inner margins. Antennæ very dark, coal black, only the third joint paler, yellowish, with the apical third blackish.

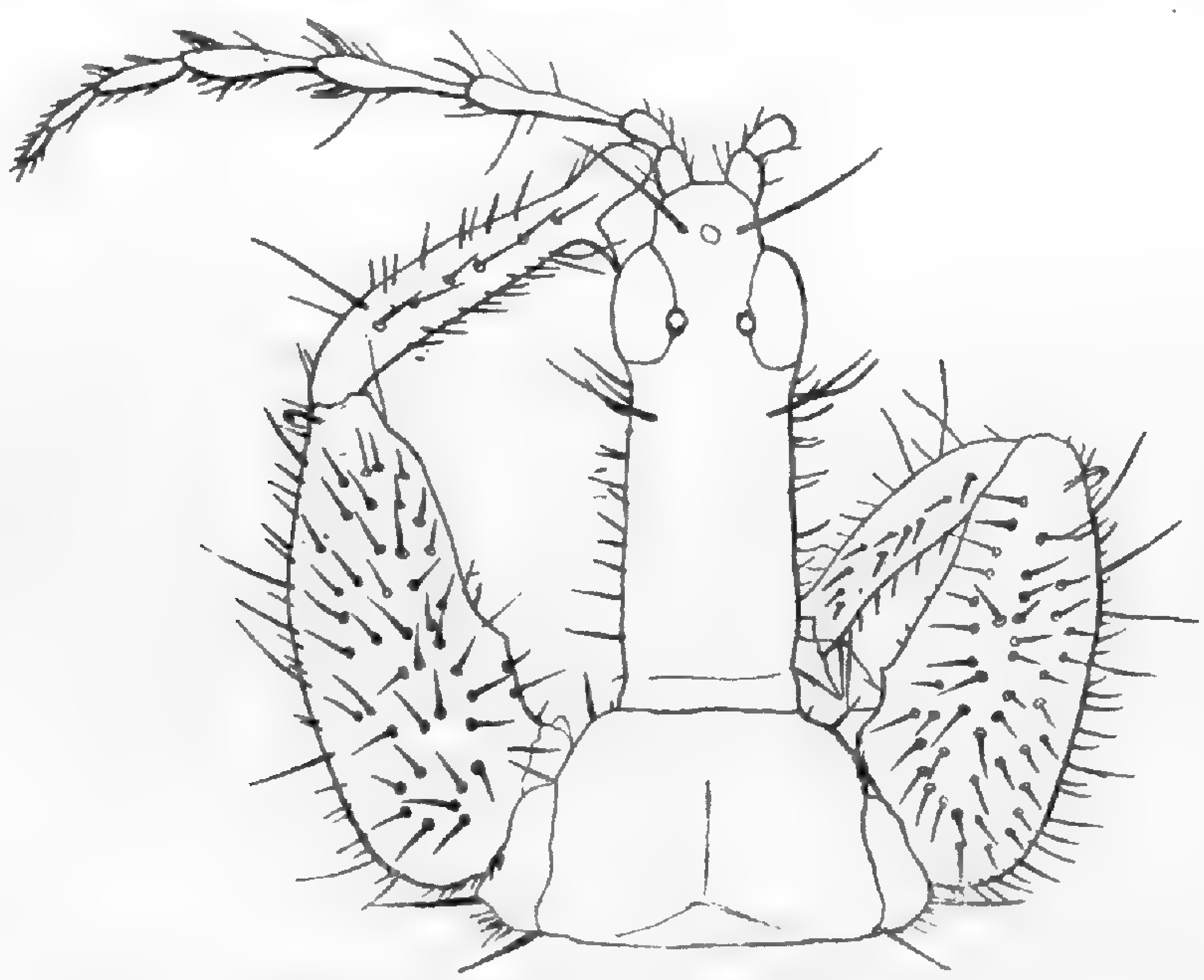

FIG. 3. Head and prothorax of *Dicaiothrips bakeri*, male.

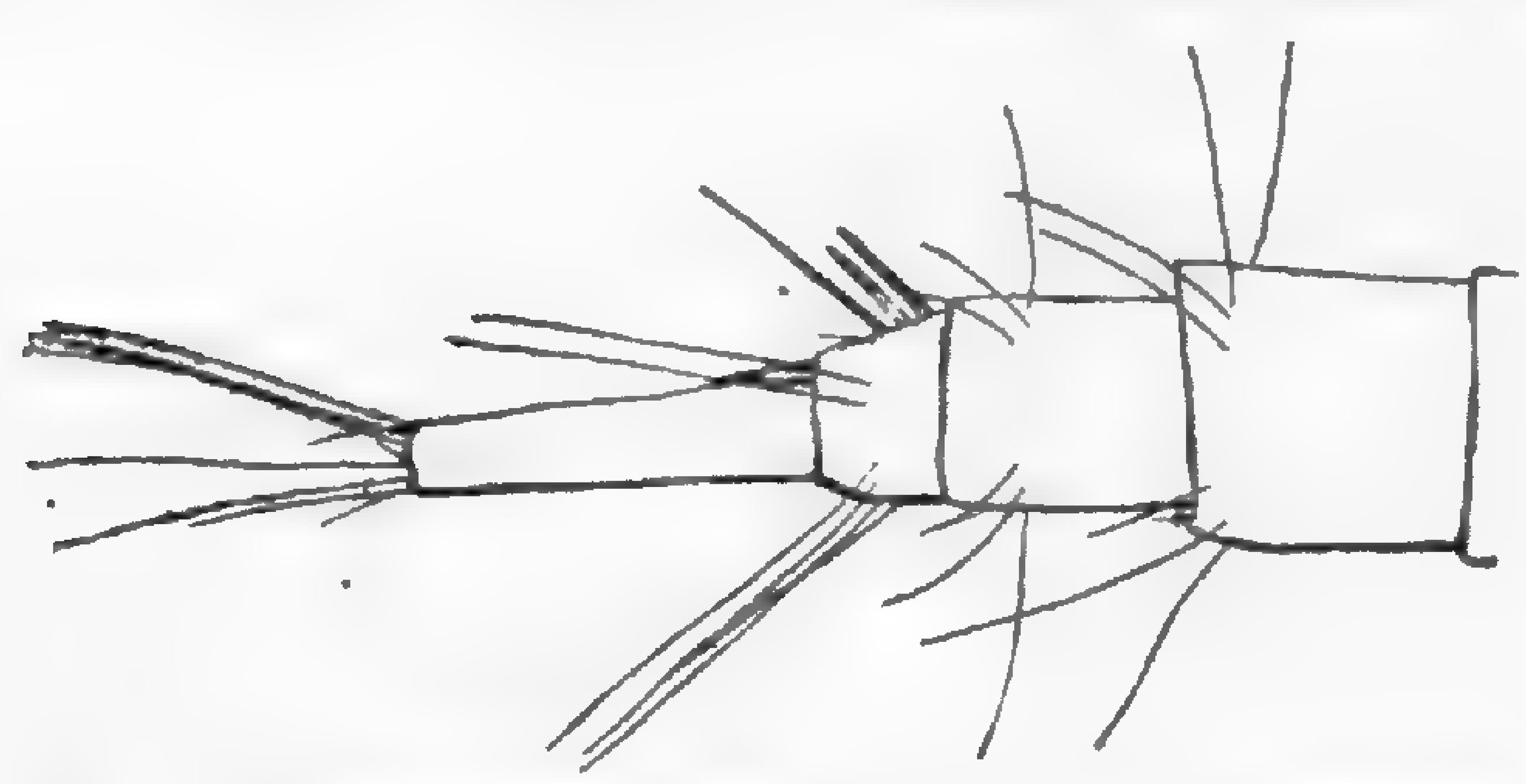

FIG. 4. *Dicaiothrips bakeri*, male; end of abdomen, lateral view.

Head about three times as long as broad, broadest across the eyes, then a little narrowed and again somewhat dilated in the basal quarter, and before the hind margin distinctly collariform and constricted. Cheeks set with numerous strong, sharply pointed spines and long postocular bristles. A pair of very long and strong knobbed bristles occurs near the anterior ocellus. The anteocular processes of the head are a little shorter than wide, with somewhat emarginated sides. Antennæ a little longer than head, bristles and hairs on every joint; especially the third and the fourth joints with a long and strong bristle, behind the middle on the outer (posterior), and near the apex on the inner (anterior) margin. Sense cones (very slender and hardly to be distinguished from the bristles) occur, one on each side of joints 3 and 4 near the apex (that of the outer margin of third joint in my specimen broken off near base); one normally developed on the inner margin of fifth joint, the outer rudimentary; sixth joint with only one sense cone on the inner margin; the two basal and the two apical joints without sense cones. Mouth cone broadly rounded at apex, a little exceeding the middle of prosternum.

Prothorax somewhat transverse, a little dilated posteriorly, including the fore coxæ twice as wide as long; with a sharp longitudinal median line; anterolateral and mediolateral bristles well developed, those of the hind margins still longer and stronger. No toothlike tubercle at the sides of prothorax. Fore coxæ set with a few short spines and a very long and strong bristle on the angle. Fore femora strongly thickened, on the inner margin with a small, blunt tubercle near the base and with a few short spines, on the outer with several longer ones and between these some that are shorter; whole surface covered with numerous spine-bearing pits; near the outer margin before the apex is a strong sickle-shaped bristle. Fore tibæ stout, on each margin set with bristles and spines, especially two or three very long ones on the basal half of the outer margin; the upper surface with a row of spine-bearing pits. Fore tarsi armed with a large triangular tooth.

Pterothorax with somewhat protruding fore margins, distinctly narrowed posteriorly. Intermediate and hind legs relatively long and stout, their femora somewhat thickened, subclavate, set with some strong bristles. Wings clear, not narrowed in the middle, reaching about to the middle of abdomen; the fore pair are, in the basal half, provided with a pale yellowish median longitudinal stripe, in the distal half, with a scarcely perceptible infumation. On the hind margin of each fore wing there are about forty-five to fifty interpolated ciliæ.

Abdomen long and slender, with the basal segments of subequal length and width, the apical segments longer than broad. Ninth segment strongly narrowed posteriorly, a third the length of the tube; this segment in the basal portion with the margins straight and subparallel, in the apical third a little converging; its breadth at base about one and one-half times its breadth at apex. All abdominal segments near the hind margin set with long bristles; those of the ninth about as long as the tube, those of tube a little shorter. The three basal segments (2 to 4) dorsally with two pairs of well-developed wing-retaining spines, the following without such. On the ventral side of the ninth abdominal segment a pair of long and very thick, straight spines (fig. 4).

I have allowed myself the pleasure of naming this interesting new species after Prof. Charles Fuller Baker, who discovered it in the Philippines.

*Measurements of Dicaiothrips bakeri sp. nov., male.*

| | Length. | Width. |
|---|---|---|
| Antennæ: | *mm.* | *mm.* |
| First joint | 0.06 | 0.06 |
| Second joint | 0.09 | 0.04 |
| Third joint | 0.23 | 0.05 |
| Fourth joint | 0.23 | 0.05 |
| Fifth joint | 0.18 | 0.04 |
| Sixth joint | 0.11 | 0.03 |
| Seventh joint | 0.085 | 0.02 |
| Eighth joint | 0.075 | 0.02 |
| Total length of antennæ | 1.06 | |
| Head | 0.8 | 0.28 |
| Prothorax | 0.35 | [a] 0.7 |
| Fore femora | 0.75 | 0.32 |
| Fore tibiæ, including tarsi | 0.65 | 0.09 |
| Pterothorax | 0.75 | 0.8 |
| Middle femora | 0.6 | 0.13 |
| Middle tibiæ, including tarsi | 0.65 | 0.06 |
| Hind femora | 0.95 | 0.1 |
| Hind tibiæ, including tarsi | 0.9 | 0.05 |
| Wing, without fringe | 2.0 | |
| Abdomen | 2.9 | 0.55 |
| Ninth segment | 0.15 | |
| Tube | 0.45 | |
| Tube, at base | | 0.12 |
| Tube, at apex | | 0.08 |
| Total length of insect | 4.8 | |

[a] Across fore coxæ.

The new species is to be recognized as a true *Dicaiothrips* by the strong sickle-shaped bristle of the fore femora and differs from the other known species by the coloration of the antennæ. There was only a single idolothripid species hitherto known from the Philippine Islands, *Idolothrips* (?) *tibialis* Ashmead, of doubtful generic position, which is much smaller and has all the tibiæ paler, yellowish. *Dicaiothrips bakeri* belongs to the group with equal third and fourth antennal segments and seems to be closely related to *D. levis* Schmutz, from Ceylon; but this species has the antennæ differently colored and a stouter tuberculated tooth on the fore tarsi of the male. *Dicaiothrips denticollis* Bagnall agrees with *bakeri* by the coloration of the antennæ, but differs by the toothlike process of the prothoracic margins and by its larger size. *Dicaiothrips bruneitarsis* Schmutz has the middle joints of antennæ paler and the fore femora of male much smaller than in *bakeri*. *Dicaiothrips procer* Schmutz differs by its larger size, its shorter vertex, and the coloration of antennæ. *Dicaiothrips greeni* Bagnall has a longer, anteriorly more produced head; light brown middle joints of antennæ, of which the fourth is distinctly shorter than the third; paler middle and hind tibiæ; and differs further by its much larger size. *Dicaiothrips dallatorrensis* Schmutz and *novus* Schmutz have different coloration of antennæ, and the anteocular process of *dallatorrensis* is a little shorter than in *bakeri*. *Dicaiothrips proximus* Bagnall, from Ceylon, is also closely related to *bakeri*, but a little longer and stouter, and has not only the third, but also the basal part of the fourth and the fifth antennal joints yellowish. *Dicaiothrips bouvieri* Vuillet is about twice as long as *bakeri*, has longer antennæ, a more strongly produced vertex, a longer and slenderer fore tarsal tooth, and paler, yellowish, middle and hind tibiæ; the third and fourth antennal joints are equal, as in *bakeri*, while the neotropical species have the fourth distinctly shorter.

PALAWAN, Puerto Princesa (leg. *Baker*), 1 male.

# ILLUSTRATIONS

TEXT FIGURES

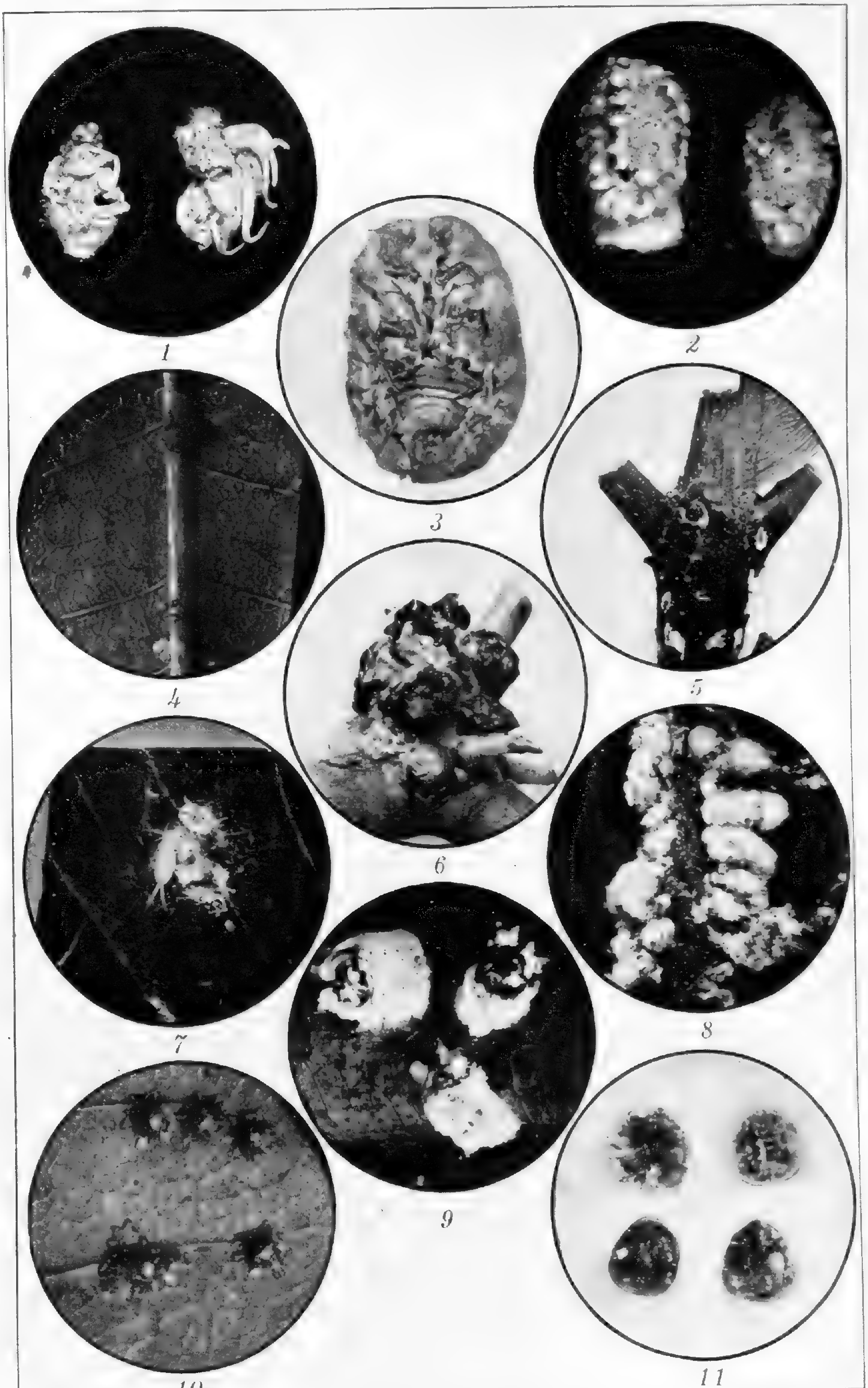


PLATE I. PHILIPPINE NONDIASPINE COCCIDÆ.

# A VOLUMETRIC METHOD FOR THE DETERMINATION OF LACTOSE BY ALKALINE POTASSIUM PERMANGANATE [1]

By FELIPE T. ADRIANO

*Of the Laboratory of Agricultural Chemistry, College of Agriculture, University of the Philippines*

Quisumbing,(7) of this laboratory, recently devised a volumetric method for the determination of glucose and starch by alkaline potassium permanganate solution, which is claimed to be shorter than, and as accurate as, any of the Fehling methods, either gravimetric or volumetric. It was thought worth while to apply this method to the determination of lactose in milk. For this purpose a lactose permanganate table similar to that for pure lactose for glucose and starch was prepared. Parallel determinations of lactose in milk were then made by the new, the Soxhlet, and the optical methods. The results show that for the determination of sugar in milk the new method, besides being more rapid, promises to be as accurate as either of the older methods, if not more so.

## PREVIOUS WORK ON MILK SUGAR DETERMINATION

So far as can be found in the available literature no quantitative method has ever been devised for the determination of lactose in milk by oxidation with potassium permanganate in alkaline solution. Greifenhagen, König, and Scholl(5) determined the ration of lactose to the amount of oxygen used when the former is oxidized in an alkaline potassium permanganate solution, but they did not work out a method for the determination of this sugar in milk. Some determinations of lactose by the older methods are given here.

[1] This investigation was undertaken at the suggestion and under the direction of Prof. M. L. Roxas. Published with the permission of the Director of the experiment station of the College of Agriculture, University of the Philippines.

Woll(10) in his report on dairy products gives the following determinations of lactose in condensed milk:

| Analyst. | Lactose. | |
|---|---|---|
| | By gravimetric method. | By polariscope. |
| | *Per cent.* | *Per cent.* |
| Jaffa and Stewart, California | 9.28 | 9.36 |
| Olson, Wisconsin | 9.91 | 9.19 |
| Jaffa and Stewart, California | 8.11 | 8.00 |
| Do | 10.87 | 10.74 |
| Do | 9.96 | 9.84 |

He called attention to the fact that the results obtained with the polariscopic method are, in all cases but one, lower than with the copper reduction gravimetric method. His observations were confirmed by the report of Patrick and Boyle(6) who, in their subreport on analysis of dairy products, gave the following results:

| Sample No. | Lactose. | |
|---|---|---|
| | By Soxhlet method. | By polariscope. |
| | *Per cent.* | *Per cent.* |
| 2930 (Referee's sample) | 10.04 | 10.07 |
| 2530 | 10.51 | 10.19 |
| 2528 | 10.69 | 10.57 |
| 2610 | 10.15 | 9.97 |
| 2529 | 9.20 | 8.71 |
| 2531 | 9.37 | 9.00 |

Folin and McEllroy(4) have recently succeeded in introducing copper phosphate mixtures, the alkaline phosphate taking the place of tartrates, citrates, or glycerol in the analysis of sugars in urine, using a modified Benedict titration method. Folin and Denis(3) have applied this method to the determination of lactose in milk and they claim that it gives accurate results. Their method as applied to milk is remarkably simple, for it does away with the preliminary preparation of protein-free filtrates, since albumin does not interfere with the titration, and it therefore "eliminates the cumbersome 'corrections' for the volume occupied by the protein-fat precipitates." In the same paper a picrate colorimetric method for lactose is described which is materially simpler than the one given by Dehn and Hartman.(2) Parallel results obtained with the colorimetric method of Folin and Denis and the titration method are given to show that the latter is the more accurate.

## MATERIALS AND PROCEDURE

### QUISUMBING'S(7) METHOD AS APPLIED TO THE DETERMINATION OF LACTOSE IN MILK

Place in an Erlenmeyer flask 50 cubic centimeters of 0.1 *N* potassium permanganate solution, 25 cubic centimeters of a solution of sodium carbonate containing 8.48 grams of (anhydrous) sodium carbonate per liter and 5 or 10 cubic centimeters of the filtrate obtained as indicated below. Add sufficient water to make the final volume of the mixture 100 cubic centimeters. Heat the mixture on the heating device, consisting of an iron tripod with asbestos hood, with the heating power so regulated that its temperature is raised from 29° C. to 95° C. in two minutes, and continue heating for another two minutes after the temperature has reached 95° C. Remove the flask and add gradually 25 cubic centimeters of 30 per cent sulphuric acid and 0.1 *N* oxalic acid solution until the liquid is clear. Titrate the excess of oxalic acid against standard 0.1 *N* potassium permanganate solution, adding the latter until the liquid assumes a pink color that remains for a few seconds. The sum of the number of cubic centimeters of 0.1 *N* potassium permanganate solution used in oxidation and in titration minus the number of cubic centimeters of 0.1 *N* oxalic acid solution gives the number of cubic centimeters of 0.1 *N* potassium permanganate solution that is actually used in oxidation The corresponding lactose value with the use of pure lactose is shown in Table 2.

The pure lactose used in obtaining the data for this table was prepared as follows:

To an alcoholic solution, saturated at 40° C. of chemically pure lactose obtained from a local dealer, absolute alcohol and ether were added, and the sugar was allowed to crystallize from the solution in a vacuum desiccator over sulphuric acid. When about half of the solvent had evaporated, the crystals were separated from the mother liquor by suction and then washed with small amounts of ether and absolute alcohol. The lactose was recrystallized three times in the manner described and the purified product dried for sixteen hours at 40° C. under vacuum in an apparatus similar to that described by Browne. (1) Its purity was determined, as follows:

1.6450 grams of the pure lactose were weighed and dissolved to 100 cubic centimeters. Twenty-five cubic centimeters of this solution were analyzed by the Soxhlet method for the lactose content, and a portion was polarized after having been allowed to stand for twenty-four hours.

TABLE 1.—*Determination of the purity of lactose.*

| Method of analysis. | Lactose. Per cent. |
|---|---|
| Optical method | 100.00 |
| Soxhlet method | 99.98 |
| Average | 99.99 |

TABLE 2.—*Determination of lactose by the alkaline potassium permanganate method.*

| Lactose. | 0.1 *N* $KMnO_4$. | Lactose. | 0.1 *N* $KMnO_4$. | Lactose. | 0.1 *N* $KMnO_4$. | Lactose | 0.1 *N* $KMnO_4$. |
|---|---|---|---|---|---|---|---|
| *mgs.* | *cc.* | *mgs.* | *cc.* | *mgs.* | *cc.* | *mgs.* | *cc.* |
| 1 | 2.51 | 11 | 12.30 | 21 | 23.63 | 31 | 34.65 |
| 2 | 3.21 | 12 | 13.80 | 22 | 24.87 | 32 | 35.69 |
| 3 | 4.04 | 13 | 15.41 | 23 | 25.92 | 33 | 36.16 |
| 4 | 4.39 | 14 | 16.72 | 24 | 26.67 | 34 | 37.26 |
| 5 | 5.47 | 15 | 17.85 | 25 | 28.10 | 35 | 38.26 |
| 6 | 6.52 | 16 | 19.04 | 26 | 28.39 | 36 | 38.64 |
| 7 | 7.69 | 17 | 20.16 | 27 | 29.50 | 37 | 39.28 |
| 8 | 9.13 | 18 | 20.96 | 28 | 30.60 | 38 | 40.16 |
| 9 | 9.98 | 19 | 21.50 | 29 | 31.49 | 39 | 40.56 |
| 10 | 11.37 | 20 | 22.89 | 30 | 32.55 | 40 | 41.47 |

## APPLICATION OF THE NEW METHOD TO THE ANALYSIS OF LACTOSE IN MILK

The milk under examination was analyzed for its lactose content by means of the optical method, the gravimetric method, and the new method, thus making possible a comparison of the results of the three methods. That the milk samples should all be of equal concentration, the evaporated canned milk was diluted by mixing equal parts of the milk and water before proceeding with the analysis. To determine which of the methods is the most accurate, similar analyses were made on "synthetic" milk prepared as indicated below. The preparation of the solution used for the gravimetric method and the new method is as follows: (8)

Dilute 25 cubic centimeters of milk of known weight with 400 cubic centimeters of distilled water in a 500 cubic centimeter graduated flask. Add 10 cubic centimeters of the copper sulphate [2] solution and 8.8 cubic centimeters of 0.5 sodium hydroxide solution. After the addition of the alkali the mixture must still have an acid reaction and contain copper in solution. Fill the flask to the 500 cubic centimeter mark; mix, filter through a dry filter, and determine the lactose in the filtrate, taking 50 cubic centimeters for the copper reduction and 10 cubic centimeters for the alkaline potassium permanganate method.

For the optical method the directions given in Sherman's Organic Analysis (9) were followed.

The results of the analysis performed on canned and on fresh cows' milk are as follows:

TABLE 3.—*Determination of lactose in milk.*

[Figures express the percentages of lactose by weight.]

| Sample. | | Lactose. | | |
|---|---|---|---|---|
| No. | Description. | Polariscope. | Quisumbing's method. | Soxhlet's method. |
| | | *Per cent.* | *Per cent.* | *Per cent.* |
| 1 | Sterilized Norway natural milk | 4.60 | 5.21 | 5.65 |
| 2 | Do | 4.56 | 5.20 | 5.64 |
| | Average | 4.580 | 5.205 | 5.645 |
| 3 | Sterilized evaporated milk | 6.12 | 9.52 | 9.76 |
| [a]4 | Do | 8.26 | 9.88 | 10.08 |
| [a]5 | Do | 7.28 | 9.70 | 9.88 |
| [a]6 | Do | 7.22 | 9.84 | 9.86 |
| | Average | 7.220 | 9.735 | 9.895 |
| 7 | Evaporated milk | 8.71 | 9.98 | 10.30 |
| 8 | Do | 8.78 | 9.99 | 10.24 |
| 9 | Do | 8.72 | 9.94 | 10.30 |
| 10 | Do | | 9.94 | 10.29 |
| | Average | 8.736 | 9.962 | 10.282 |
| 11 | Sterilized natural milk | 4.41 | 4.50 | 4.52 |
| 12 | Do | 4.42 | 4.46 | 4.62 |
| 13 | Do | 4.38 | 4.53 | 4.46 |
| 14 | Do | 4.38 | 4.46 | 4.73 |
| | Average | 4.395 | 4.487 | 4.582 |
| 15 | Cows' milk from Los Baños | 4.50 | 4.80 | 5.08 |
| 16 | Do | 4.48 | 4.79 | 5.06 |
| | Average | 4.490 | 4.795 | 5.070 |

[a] These samples were taken from the same can as No. 3, but they were treated with varying amounts of pure lactose. The percentage of lactose added was subtracted to find the true percentage of lactose in the milk.

[2] Dissolve 34,639 grams of copper sulphate in 100 cubic centimeters of water and dilute to 1 liter.

## ANALYSIS OF SYNTHETIC MILK

For the purpose of determining which of the three methods will give the most accurate results, analyses were made of "synthetic" milk, which was prepared in the laboratory by mixing:

| | Per cent. |
|---|---|
| Water | 87.75 |
| Fat (in the form of butter) | 3.40 |
| Protein (in the form of casein) | 3.50 |
| Pure lactose | 4.60 |
| Mineral substances from the ash of canned milk | 0.75 |

The results are shown in Table 4.

TABLE 4.—*Analyses of synthetic milk.*

| Sample No. | Lactose. | | |
|---|---|---|---|
| | Polariscopic method. | Quisumbing's method. | Soxhlet's method. |
| | *Per cent.* | *Per cent.* | *Per cent.* |
| 1 | 4.24 | 4.78 | 4.80 |
| 2 | 4.16 | 4.77 | 4.80 |
| Per cent of lactose added | 4.60 | 4.60 | 4.60 |

## DISCUSSION OF RESULTS

Table 2 gives the milligrams of lactose corresponding to the number of cubic centimeters of 0.1 *N* potassium permanganate solution used in the determination as described. Table 3 shows the results of the analysis of the different samples of milk by the three methods. Table 4 gives the results with synthetic milk with a known percentage of lactose. From these tables it may be seen that the percentage of milk sugar given by the optical method is consistently lower than by the Quisumbing or the Soxhlet method, and also that the Quisumbing method gave lower results than did the Soxhlet. The differences between the polariscopic method and the two oxidation methods are in most cases serious, whereas the oxidation methods may be considered to agree closely. The differences between the polariscopic method and the two oxidation methods are greater in the case of the sterilized evaporated milk than in that of the sterilized natural milk or the fresh cows' milk (see Table 3). It was thought that the differences might be due to changes in the sterilized evaporated milk that occur during manufacture but which do not occur in the sterilized natural milk or in the fresh cows' milk, and that such changes resulted in the formation of soluble products not precipitated by acid mercuric nitrate. The proteins or milk are most susceptible to hydrolysis during the process of evaporation, and would give rise to optically active products which may not be precipitated by mercuric nitrate. To test this point the filtrates from samples 7 to 10, 11 to 14, and 15 and 16 (Table 3) were analyzed for their nitrogen content by the Kjeldahl Gunning Arnold(8) method with the following results:

TABLE 5.—*Nitrogen determination of filtrates from samples 7 to 10, 11 to 14, 15 and 16 (Table 3).*

| Source of sample. | Nitrogen in samples— | | |
|---|---|---|---|
| | 7 to 10. | 11 to 14. | 15 and 16. |
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Filtrate for the polariscopic method | 0.0110 | 0.0130 | 0.0021 |
| Calculated as milligrams alanin in 100 cubic centimeters of filtrate | 70.00 | 82.50 | 12.70 |
| Filtrate for the reduction methods | 0.0006 | 0.0056 | 0.0016 |

These results show that hydrolysis of the protein occurs in the process of evaporation and sterilization of milk. Thus the fresh cows' milk gives less nitrogen in the filtrate than either the evaporated or the sterilized milk. The differences are clearly seen if the nitrogen is expressed in milligrams of a dipeptid or an amino acid such as alanin. Of course, nothing is known of the nature of these nitrogenous compounds. But, judging from the results of the analysis of samples 7 to 10, where the average difference between the polariscopic method and the two oxidation methods is greater than 1 per cent, and of samples 11 to 14, where the optical and the oxidation methods agree to within 0.1 per cent—both giving almost the same percentage of nitrogen in the filtrate—these soluble products may influence the rotation of lactose in either direction. It is very likely that other factors have an influence on the specific rotation of this sugar. This seems to be indicated by the results with synthetic milk. The casein used in the preparation of the latter must have been completely reprecipitated together with the fat by the acid mercuric nitrate, since hydrolysis of the casein was hardly possible under the conditions of the experiments; and yet the results of the sugar analysis by the polariscopic method are much lower than by the oxidation methods. Of course, no definite conclusions can yet be drawn from the results of only one set of experiments, but there are some indications that the mercuric nitrate, the ash, or the nitric acid, or all three, affect also the specific rotation of lactose. The influence of the factors seems to be cumulative in the case of the evaporated milk and compensating in the case of the sterilized milk.

## SUMMARY AND CONCLUSIONS

The attempt to apply the alkaline potassium permanganate method to the determination of lactose in milk has met with success. This method has advantages over the older methods in rapidity and accuracy. Lactose determinations run with the new method give consistently lower results than with the Soxhlet method.

The results obtained by the polariscopic method are very unreliable and cannot be used for accurate work, especially in the analysis of canned milk. Where a high degree of accuracy in the results is required the Quisumbing or Soxhlet method should be given preference.

## BIBLIOGRAPHY

1. BROWNE, C. A. Handbook of Sugar Analysis. London (1912) 23.
2. DEHN, WILLIAM M., and HARTMAN, F. A. The picrate colorimetric method for the estimation of carbohydrates. Journ. Am. Chem. Soc. **32** (1914) 404.
3. FOLIN, O., and DENIS, W. The determination of lactose in milk. Journ. Biol. Chem. **33** (1918) 521–524.
4. FOLIN, O., and MCELLROY, W. S. Copper phosphate mixtures as sugar reagents. Journ. Biol. Chem. **33** (1918) 513.
5. GREIFENHAGEN, W., KÖNIG, J., and SCHOLL, A. Bestimmung der Kohlenhydrate durch Oxydation mittels Kaliumpermanganat in alkalischer Lösung. Biochem. Zeitschr. **35** (1911) 177.
6. PATRICK, G. E., and BOYLE, M. Sub-report on analysis of dairy products. Bull. U. S. Dept. Agr., Bur. Chem. **105** (1907) 106.
7. QUISUMBING, F. A. Determination of glucose and starch by the alkaline potassium permanganate method. Philip. Journ. Sci. **16** (1920) 581.
8. Report of the Committee on Editing Tentative and Official Methods of Analysis. Published in the Journal of the Association of Official Agricultural Chemists. Bulletins 1 and 2 (one volume) 87, 104, 289 (1916).
9. SHERMAN, H. C. Organic Analysis. New York (1912) 361.
10. WOLL, F. W. Report on dairy products. Bull. U. S. Dept. Agr., Bur. Chem. **105** (1907) 100.

# SOME BEES FROM SANDAKAN, BORNEO

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Borneo undoubtedly possesses a very large bee fauna, as yet imperfectly known. Collections from different widely separated localities furnish different species; and, while it is not yet possible to reach definite conclusions, there are some indications that there may be greater specific diversity in different parts of Borneo than in the Philippines, in spite of the fact that the latter area is divided into many islands. Sandakan, in North Borneo, is only about 250 miles from Mindanao; but its fauna appears to be very different in many respects from that of the Philippines. Especially striking is the great abundance and variety of *Trigona,* a genus represented by few species in the Philippines and, so far as we yet know, not present on Mindanao at all. Another remarkable fact is the presence of the genus *Heterapis* at Sandakan, a genus of minute and very peculiar bees, previously known only from three Australian species.

All the Sandakan material was received from Prof. C. F. Baker.

## Genus **NOMIA** Latreille

**Nomia strigata** (Fabricius).

The specimens from Sandakan appear to represent a single species, but the variations are very striking, as follows:

Variety *a*. Abdominal bands bright emerald green suffused or shot with brilliant violet. Female, *Baker 9614;* male, *Baker 9613.*

Variety *b*. Larger than *a;* fourth band as in *a*, the others yellower green, without violet. Female.

Variety *c*. All the bands bright yellowish green suffused with pale vermilion. Male. This is variety *ridleyi* (Cockerell), already known from Singapore, Java, and the Philippines.

**Nomia iridescens** Smith.

One female of variety *rhodochlora* Cockerell, described from Mindanao and Negros. The first two abdominal segments entirely lack the metallic color seen in a specimen of *N. iridescens* from F. Smith's collection.

**Nomia tuberculifrons** sp. nov.

*Female.*—Length, a little over 10 millimeters; black, with four rather broad, very bright, emerald green bands (slightly tinged with red) on abdomen; legs ferruginous, with pale fulvous hair; wings dilute reddish fuliginous, the second submarginal cell large and square; supraclypeal area with a strong elevation or tubercle, representing the lower end of the frontal keel; clypeus shining, sparsely and not strongly punctured, reddish apically, depressed in middle, wholly without a keel, but with a low elevation or boss on each side; head and thorax with pale fulvous hair; mesothorax and scutellum with thin inconspicuous hair; mesothorax dullish and practically impunctate, except the disc posteriorly, which is shining and evidently punctured; scutellum slightly bigibbous, the bosses shining; postscutellum unarmed; tegulæ fulvous. Antennæ strongly reddened on underside. Hair of abdomen above, except basally, black, but on underside pale fulvous.

BORNEO, Sandakan, 2 females. This belongs to a little group of species which includes *N. elegans* Smith, *N. borneana* Cameron, and *N. erythropoda* Cameron. *Nomia elegans* differs by the hyaline wings and blue-green abdominal bands. (A specimen from Celebes, standing in the British Museum as *N. elegans*, differs from Smith's description, having the abdominal bands yellow-green shot with vermilion.) *Nomia borneana*, based on a female collected by Shelford, differs by the hyaline wings with pale nervures, but agrees in the tubercle on face. Cameron says that *borneana* is close to *elegans*, which may be known from it by the clypeus being coarsely punctured, subtuberculate on each side, and with a central longitudinal depression. Our insect has the clypeus as here described for *elegans*, except that it is sparsely and not very coarsely punctured. *Nomia erythropoda*, based on a male from Kinghang, has no bright-colored band on first abdominal segment; the wings are hyaline, with the radial and cubital cells smoky; the lower part of front and face are keeled in the center. According to Meade-Waldo, *erythropoda* and *borneana* are the same species.

The following key will be useful for the separation of the Bornean species of *Nomia:*

Wings dark violaceous; female, 12 millimeters long (Kuching).
**violaceipennis** Cameron.
Wings hyaline or smoky (fusco-violaceous at apex in *robusta*) .................. 1.

1. Abdomen clavate; legs rufotestaceous; male (Sarawak). ceratina (Smith).
   Abdomen not clavate .......... 2.
2. Large species (14 millimeters long); apices of abdominal segments with fulvous hair bands; female .......... robusta Cameron.
   Smaller, 11 millimeters or less .......... 3.
3. Yellow-orange, with black or blackish marks, abdomen with eight dark spots; wings clear, slightly dusky, nervures yellow; scutellum bigibbous; male, 8 millimeters long (Liangtelan) .......... gribodoi Vachal.
   Abdominal segments with pubescent bands; female, 7 millimeters long (Bidi) .......... bidiensis Cameron.
   (*N. bicarmata* Cameron, misprint for *bicarinata*, was based on specimens from Kuching. Meade-Waldo states that a specimen labeled *bicarinata* by Cameron is identical with *bidiensis*. According to the descriptions, the stigma is pale testaceous in *bidiensis*, fuscous in "*bicarmata*.")
   Abdomen with three cream-white bands; much of the abdomen red; female, 8 millimeters (Bidi, Sarawak) .......... leucozonata Cameron.
   Abdomen with blue or green bands .......... 4.
4. Legs fulvous .......... 5.
   Legs black .......... 6.
5. Wings hyaline; female, 11 millimeters; male, 9 to 10 millimeters. borneana Cameron (erythropoda Cameron).
   Wings reddish fuliginous .......... tuberculifrons Cockerell.
6. Thorax densely covered with fulvous pubescence; male, 11 millimeters. varibalteata Cameron.
   Thorax not thus covered with fulvous hair; clypeus keeled .......... 7.
7. First abdominal segment with a blue or green band. strigata (Fabricius).
   First segment without such a band .......... iridescens Smith, var. rhodochlora Cockerell.

## Genus APIS Linnæus

**Apis indica sinensis** (Smith).

The single worker before me agrees best with the Chinese subspecies, *sinensis*. It differs a little in wholly lacking bands of gray tomentum at bases of abdominal segments 3 to 5 and in the clear yellow scutellum. The dark hair on the front is very long and abundant. Possibly a Bornean race may be recognized when we have more material.

*Apis florea* Fabricius and *A. dorsata* Fabricius were also found at Sandakan.

## Genus NOMADA Scopoli

**Nomada sandacana sp. nov.**

*Male.*—Length, about 5 millimeters; bright ferruginous, with the region of the ocelli and two large triangular marks on first abdominal segment black; head broad, eyes green; mandibles simple; antennæ very long; scape long and swollen, bright red; flagellum black, obscurely reddish beneath; third antennal joint long, equal to fourth; mesothorax dull; scutellum presenting two large brighter red spots, close together; base of metathorax largely shining; tegulæ red; wings dusky on apical margin; stigma and nervures dark brown; basal nervure going basad of transverse median; three submarginal cells, second receiving recurrent nervure in middle; abdomen broad, shining, apical plate deeply notched; legs red, the hind femora with a dark mark above near end.

BORNEO, Sandakan. Nearest to *N. testaceobalteata* Cameron from Kuching, Borneo, but easily known by the almost entirely red color, like that of a female. It is very distinct from all the Philippine species.

### Genus **MEGACHILE** Latreille

**Megachile tarsatula** Cockerell.

A female from Sandakan (*Baker 9969*) does not differ from those collected in the Philippines (Mindanao, Palawan, and Negros).

### Genus **PROSOPIS** Fabricius

**Prosopis opacissima** Cockerell.

*Male.*—Length, about or nearly 5 millimeters; not very robust; black, with the following parts lemon yellow: Clypeus, cuneiform lateral face marks (filling space between clypeus and eye, and ending broadly but obliquely above at antennæ), labrum except margin, greater part of mandibles, interrupted band on prothorax (not nearly reaching tubercles), tubercles, spot on tegulæ, anterior tibiæ except a large spot behind, basal half of middle and hind tibiæ, and all the tarsi (small joints rufescent). Eyes strongly converging below, so that lower part of face is narrowed; antennæ long, scape with a yellowish stripe, flagellum dusky ferruginous beneath; front densely and minutely punctured; mesothorax dull and densely punctured; scutellum with larger less-crowded punctures; area of metathorax with transverse sulci, the whole effect resembling the picture of a bird in flight; wings dusky, stigma and nervures dark, first recurrent nervures meeting first transversocubital; abdomen shining on first two segments, with excessively fine punctures, third and following segments dull; sides of first segment with small fringes of white hair (*Baker 9985*).

*Female.*—Like the male, but face marks reduced to three; namely, a very broad band on clypeus (sometimes rounded, sometimes slightly emarginate, above), and lateral face marks; the latter keeping the cuneiform shape, but separated from the clypeal mark, and their lower ends scarcely going down as far as middle of clypeal band (*Baker 9987*).

BORNEO, Sandakan; 1 male, 4 females. The male is extremely close to *P. taclobana* Cockerell, from Leyte; but the mesothorax is more coarsely sculptured, the wings are browner, and there is less yellow on the scape. I cannot separate the female from the Philippine *P. opacissima*, which has hitherto been known only in that sex.

**Prosopis borneensis sp. nov.**

*Female.*—Length, about 6 millimeters, robust; black, with yellow markings as follows: Large cuneiform mark on clypeus (the point upward), broad-triangular lateral face marks (filling space between clypeus and eye, and ending on the orbits at an angle of about 45 degrees, a little above level of antennæ), interrupted band on prothorax (not nearly reaching tubercles), tubercles, large spot on tegulæ (which are piceous posteriorly), and all the tibiæ at base (the anterior and posterior ones broadly, the middle slightly). Tarsi black; mandibles with a subapical spot; antennæ black, flagellum ferruginous beneath apically. Face broad; front dull; mesothorax distinctly and very densely punctured, posterior middle more shining and not so closely punctured; scutellum shining, and with large punctures; base of metathorax with rugæ forming an irregular reticulation; sides of metathorax pruinose with fine pale pubescence; wings hyaline, slightly dusky, stigma and nervures black; first recurrent nervure meeting first transversocubital; second submarginal cell broad; abdomen shining, hind margins of segments laterally with fine pruinose pubescence. The apical ventral segment is sheathlike, inclosing the sting.

BORNEO, Sandakan. Related to *P. mindanensis* Cockerell, from Mindanao. Only the male of *mindanensis* is known, but the Bornean insect has the wings distinctly brownish, and the scutellum and posterior part of mesothorax less densely punctured, so I think it is certainly distinct. The lateral face marks of *mindanensis* have the upward extension linear instead of broadly angular.

*Proposis hewittii* Cameron, from Borneo, is an *Allodape.*

### Genus **ALLODAPE** Lepeletier

**Allodape hewittii** (Cameron) var. **sandacanensis** var. nov.

Meade-Waldo considered the *Prosopis hewittii* Cameron, from Kuching, to be *Allodape marginata* Smith. It differs, however, in being much smaller, and having the face mark (female) as in *A. sauteriella* Cockerell, from Formosa. The present insect agrees with Cameron's description, except that the face mark and tubercles are ivory color instead of lemon yellow, the light band on prothoracic margin consists only of white pubescence, and the palpi are not black. The thin hair on abdomen above is not all blackish. Part of the difference may be due to error in Cameron's description, but we seem to have at least a distinct variety (*Baker 9979*).

**Allodape marginata** Smith.

One female, with more glistening pale hair on the last three abdominal segments than in the Luzon form.

**Allodape cupulifera** Vachal.

Six females; a variable lot, but apparently all one species (*Baker 9978, 9980*).

### Genus **HERIADES** Spinola

**Heriades bakeri** sp. nov.

*Female.*—Length, 6 millimeters; black, of the usual form; clypeus simple; mandibles with two large teeth, and the inner corner approximately rectangular; a broad band of dense white hair along each inner orbit; antennæ black; tubercles densely fringed with pure white hair; tegulæ black; wings conspicuously dusky; first three abdominal segments with narrow but conspicuous white hair bands; ventral scopa white.

BORNEO, Sandakan (*Baker 9971*). Very much like *H. sauteri philippinensis* Friese, from the Philippine Islands (Luzon), but easily known by the smaller punctures of mesothorax. In typical *H. sauteri* from Formosa these punctures are about 50 microns wide; in *philippinensis,* about 35; in *bakeri,* 24 to 30. In the new species *bakeri* the wings are conspicuously darker than in the variety *philippinensis.*

**Heriades fulvescens** sp. nov.

*Male.*—Length, about 4.2 millimeters; black, of the usual form. I at first took it for granted that this was the male of *bakeri,* but this cannot be, as the mesothorax has large punctures like those of *H. sauteri,* the wings are clear, and the hair at sides of face, on scutellum, etc., is pale fulvous. The antennæ are slender, but not so long as in *H. othonis* Friese, from Java. The upper part of truncation of mesothorax is polished and brilliantly shining.

BORNEO, Sandakan (*Baker 9972*). The second submarginal cell is shorter than in the European *H. truncarum* (Linn.), and the second recurrent nervure joins it very near the end.

## Genus **CERATINA** Latreille

**Ceratina collusor** Cockerell, variety *a.*

*Male.*—Nearly agrees with type from Singapore, differing in that the scape has only one yellow spot (the lower one), and there are some punctures between the parapsidal grooves and the lateral yellow lines on mesothorax. Those may represent mere individual variation.

*Female.*—Like *C. philippinensis nigrolateralis* Cockerell, from Palawan, but differing thus: Labrum with a yellow spot; upper part of clypeal mark much larger and broader, emarginate at upper end; second submarginal cell smaller; first abdominal segment with a broad yellow hind margin, on which are two black spots; band on second segment entire, on third narrowly interrupted. There is no yellow spot behind the tubercles. The bands at sides of face are long. The hind tibiæ are yellow at base, and have a small sharp spine on outer side near end of first third. There is a similar spine in *nigrolateralis.*

BORNEO, Sandakan (*Baker 9973*). *Ceratina collusor* was described from the male, *nigrolateralis* from the female, but they are evidently very closely allied. The Bornean insect is *collusor;* perhaps a slightly modified race.

**Ceratina flavonitens** sp. nov.

*Male.*—Length, about 5.5 millimeters; shining, black, with the following parts bright chrome yellow: Labrum, mandibles, broad band behind whole length of eyes, clypeus except narrow band on each side, subtriangular supraclypeal mark, spots on front, inner orbits to vertex (the upper half of the band slender), prothorax with tubercles, mesopleura (black in front), metathorax (basal middle black), four stripes on mesothorax, scutellum, postscutellum, legs except hind tibiæ (which are black, with base and apex yellow), first abdominal segment except two very large black marks, bands on segments 2 to 6, and entire middle of sixth. Venter yellowish except apically. Face narrow, polished; flagellum dark, only moderately long; mesothorax smooth and polished, punctured anteriorly; tegulæ rufotestaceous; wings strongly reddened; stigma long, piceous; apical plate of abdomen fulvous-margined, broadly rounded, obtusely subangulate at sides, faintly subangulate in middle, but wholly without a salient point.

BORNEO, Sandakan. Readily known from *C. flavopicta* Smith, from Sarawak, by the smaller size and yellow pleura. It is perhaps nearest to the much larger *C. ridleyi* Cockerell, but differs in a number of characters.

### BEES PREVIOUSLY RECORDED FROM SANDAKAN

#### BAKER COLLECTION

*Xylocopa collaris* Lepeletier.
*Megachile facetula* Cockerell.*
*Megachile sandacana* Cockerell.*
*Megachile atrata fulvipennis* (Smith).
*Dianthidium meliponiforme* Cockerell.
*Anthophora borneensis* (Cockerell).
*Anthophora zonata andrewsi* (Cockerell.)
*Crocisa angulifera* Cockerell.*
*Crocisa crucifera* Cockerell.
*Ceratina sexmaculata* Smith.
*Heterapis sandacanensis* Cockerell.*
*Trigona melanotricha* Cockerell.*
*Trigona rufibasalis* Cockerell.*
*Trigona melina* Gribodo.
*Trigona apicalis* Smith.
*Trigona ambusta* Cockerell.
*Trigona busara* Cockerell.
*Trigona melanocephala* Gribodo.
*Trigona geissleri* Friese (var. *a*).
*Trigona sandacana* Cockerell.*
*Trigona hæmatoptera* Cockerell.*
*Trigona breviceps* Cockerell.*
*Trigona trochanterica* Cockerell.*
*Trigona fuscibasis* Cockerell.*
*Trigona scintillans* Cockerell.*
*Apis florea andraeiformis* (Smith).

Sandakan is the type locality of those marked with an asterisk. The Sandakan bees seen by me include fourteen genera and forty-two species. One of the genera (*Heterapis*) has not been found in the Philippines. Of the species, only twelve are also known from the Philippines, and in two of these the Sandakan insect is a distinct variety. The species described as new from Sandakan number nineteen.

Hewitt sent Cameron many bees from Sarawak. None of the new species described by Cameron are in the Sandakan collection, except *Allodape hewittii,* which is represented by an apparently distinct variety.

One would expect to find resemblance between the Sandakan fauna and that of Palawan. The bees known from Palawan are the following; those marked with an asterisk are not known from any other island:

BEES RECORDED FROM PALAWAN

*Prosopis palavanica* Cockerell.*
*Halictus philippinensis* Ashmead.
*Halictus caroli* Cockerell.*
*Nomioides valdezi* Cockerell.
*Nomia quadrifasciata notha* (Cockerell).
*Nomia strigata* (Fabricius).
*Nomia lusoria* Cockerell.*
*Nomia elongatula* Cockerell.
*Nomia palavanica* Cockerell.*
*Nomada palavanica* Cockerell.*
*Dianthidium minutissimum* (Bingham).
*Megachile tarsatula* Cockerell.
*Megachile philippinensis* Friese.
*Ceratina philippinensis* Ashmead.
*Ceratina philippinensis nigrolateralis* Cockerell.*
*Ceratina humilior* (Cockerell).*
*Ceratina fuliginosa* Cockerell.*
*Xylocopa nigrocoerulea* Smith.
*Xylocopa fuliginata* Pérez.
*Xylocopa mimetica* Cockerell.*
*Mesotrichia amauroptera* (Pérez).*
*Mesotrichia sulcifrons* (Pérez).*
*Mesotrichia vachali* (Pérez).*
*Mesotrichia latipes basiloptera* Cockerell.*
*Trigona palavanica* Cockerell.*
*Trigona luteiventris* Friese.
*Apis florea rufiventris* Friese.

Thus Palawan has twenty-six recorded species, about half not known elsewhere. Only three of these species are in the Sandakan list, and two of these occur elsewhere in the Philippines. The third, *Apis florea*, is represented by a distinct variety. *Dianthidium*, a genus found at Sandakan, is recorded in the Philippines only from Palawan. Palawan has two species of *Trigona*, while only a single species is known from elsewhere in the Philippines. Although these lists are very incomplete, it is evident that the bee fauna of Palawan is not closely related to that of Sandakan. About a quarter of the Sandakan species are known from the Philippines, excluding Palawan. About a third of the Palawan species are known from other Philippine Islands, but it is possible that some of these, nesting in wood or stems of plants, may have been accidentally introduced by man. The present indications are, then, that the bee fauna of Palawan is largely endemic, and has more resemblance to that of the other Philippine Islands than to that of North Borneo.

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# NEW PHILIPPINE GALL MIDGES

By E. P. FELT

*State Entomologist, Albany, New York*

The present account, based on a small collection of gall midges recently at hand, is a continuation of previous studies.[1]

The five species in this lot reveal the presence in the Philippines of the European *Stenodiplosis geniculati* Reut., known also from New Zealand and recorded from the last locality as seriously damaging the developing seed of *Alopecurus pratensis.* The Philippine record indicates a probable wide distribution of this species, and its being reared in the Islands from panicles of *Panicum crus-galli* Linn. suggests that this midge may develop in the seeds of various grasses.

The occurrence of a species presumably congeneric with a peculiar South American form is of more than ordinary interest, especially as we have no record of *Scheueria* from other parts of the world. It should also be pointed out that known species of *Toxomyia* are fungivorous, and in view of this it may be demonstrated later that the two females referred to this genus really developed from fungus-feeding larvæ rather than from gall producers.

This small collection was received through the courtesy of Mr. Leopoldo B. Uichanco, of the department of entomology, College of Agriculture, University of the Philippines.

**Scheueria scheffleræ** sp. nov.

*Female.*—Length, 1.25 millimeters. Antennæ extending to base of abdomen, rather thickly haired, dark brown, of 17 segments, the first broadly obconic, the second globose, the third and fourth narrowly fused, the fifth with a length one-fourth greater than its diameter, sparse basal and subapical whorls of long, stout setæ and low circumfila united by transverse fila near the basal third, and subapically. Terminal segment somewhat produced, broadly oval, with a length about twice its diameter. Palpi uniarticulate, the one segment broadly, irreg-

[1] Felt, E. P., New Philippine Gall Midges with a Key to the Itonididæ, Philip. Journ. Sci. § D 13 (1918) 281; 14 (1919) 287.

ularly oval and sparsely setose. Eyes holoptic. Mesonotum fuscous yellowish. Scutellum pale yellowish. Postscutellum a little darker. Abdomen rather thickly haired, reddish brown. Wings, with the costa dark brown, the membrane rather thickly scaled. Subcosta unites with costa at the basal third, the third vein just before the apex of the wing, the fifth at the distal third, its branch near the basal third. Halteres yellowish basally, fuscous apically. Coxæ reddish brown. Femora and tibiæ mostly yellowish brown. Tarsi dark brown or black. Claws moderately stout, strongly curved, unidentate, the pulvilli as long as the claws. Ovipositor stout, with a length about one-fourth of abdomen, the terminal lobes broadly and roundly triangular and rather thickly setose.

*Type.*—Cecid. a3052, New York State collection.

LUZON, Laguna Province, Mount Maquiling, March 16, 1919, College of Agriculture accession No. 18437 (*Uichanco*).

The one female is doubtfully referred to this Chilian genus. It is recorded as having been reared from leaf galls on *Schefflera insularum* Harms. Elevation about 300 meters.

**Lasioptera paniculi sp. nov.**

*Female.*—Length, 1.5 millimeters. Antennæ extending to the base of the abdomen, sparsely haired, dark brown, with at least 10 and possibly 15 segments, the fifth with a length a little greater than its diameter, all rather thickly clothed with moderately long, curved, stout setæ. Terminal segment reduced, narrowly oval. Palpi, first segment roundly quadrate, second with a length nearly twice its diameter, third one-half longer than second, fourth a little longer and slenderer than third. Mesonotum light reddish brown. Scutellum and postscutellum yellowish. Abdomen mostly yellowish brown, wings hyaline, costa dark brown, subcosta uniting with costa before basal third, the third vein well beyond basal half, the fifth joining posterior margin at distal fourth, its branch near basal half. Halteres, coxæ, and base of femora pale yellowish; distal portion of femora, tibiæ and tarsi dark brown. Claws moderately long, stout, the pulvilli nearly as long as the claws. Ovipositor with a length about one-half that of abdomen, the terminal lobes broadly oval, sparsely setose. At base there is an irregular group of about eight stout, curved hooks.

*Type.*—Cecid. a3051, New York State collection.

*Male.*—The one specimen is apparently identical in size and color with the female and, although it had lost its antennæ, is deemed worthy of description. Genitalia: Basal clasp segment rather long, slender; terminal clasp segment moderately short, stout; dorsal plate short, broad, deeply and rather narrowly emarginate, the lobes broad and tapering to a broadly rounded, sparsely setose apex; ventral plate long, broad, and broadly rounded apically; harpes long, slender, irregular apically.

LUZON, Laguna Province, Los Baños, January 22, 1919, College of Agriculture accession No. 18419 (*Uichanco*).

The small midges bore the following data: From panicles of *Panicum carinatum* Presl. Elevation about 50 meters. This insect is with little question undescribed and it is therefore characterized as new.

**Toxomyia brideliæ sp. nov.**

*Female.*—Length, 1.5 millimeters. Antennæ nearly as long as body, sparsely haired, light brown, of 14 segments, the fifth with the stems one-half the length of the cylindric basal enlargement, which latter has a length about two and one-half times its diameter, a sparse whorl of stout setæ, a broad subapical whorl, thicker on one surface, of stout setæ and low circumfila at the basal third and apically. Terminal segment produced, with a length over four times its diameter, and a short, stout, rudimentary fifteenth segment. Palpi, first segment roundly quadrate, second with a length twice its diameter, third one-half longer than second, slenderer, fourth a little longer than third and somewhat dilated. Mesonotum reddish brown. Scutellum yellowish brown, postscutellum dark reddish brown. Abdomen light brown. Wings hyaline, subcosta uniting with margin near basal third, the third vein just beyond apex and the fifth joining posterior margin at the distal third, its branch near the basal third. Halteres yellowish basally, yellowish brown apically. Legs mostly dark straw. Claws moderately long, strongly curved, the anterior unidentate, the pulvilli as long as the claws. Ovipositor about one-fourth the length of abdomen, the terminal lobes narrowly triangular, with a length over twice the width, the narrowly rounded apex with a few coarse setæ.

*Type.*—Cecid. a3049, New York State collection.

LUZON, Laguna Province, Los Baños, January 2, 1919, College of Agriculture accession No. 18146 (*Uichanco*).

Two specimens of this midge were received with the accompanying data: Gall makers on leaves of *Bridelia stipularis* (L.) Blume. Elevation about 50 meters.

**Mycodiplosis spondiasi** sp. nov.

*Female.*—Length, 0.6 millimeters. Antennæ about one-half the length of body, sparsely haired, dark reddish brown, with 14 segments, the fifth with a stem one-fourth the length of the cylindrical basal enlargement, which latter has a length two and one-half times its diameter, a sparse basal whorl of stout setæ, a subapical band of longer, curved setæ, and rather high circumfila at the basal third and apically. Terminal segment produced with a length about three times its diameter and tapering to an acute apex. Palpi, first segment subquadrate, second with a length three times its diameter, third as long as second, slenderer, fourth one-half longer than third. Mesonotum reddish brown, scutellum and postscutellum pale yellowish. Abdomen fuscous yellowish. Wings hyaline, subcosta uniting with costa near basal third, the third vein at apex of wing and the fifth at distal fourth, its branch near basal half. Halteres and coxæ pale yellowish, legs mostly dark brown. Claws rather stout, strongly curved basally, the anterior unidentate, the pulvilli about half the length of the claws. Ovipositor stout, about one-fourth the length of abdomen, the entire organ rather distinctly chitinized. Terminal lobes narrowly ovate, tapering somewhat distally and sparsely setose.

*Type.*—Cecid. a3053, New York State collection.

LUZON, Laguna Province, Los Baños, February 18, 1919, College of Agriculture accession No. 18491 (*C. S. Banks*).

A series of females doubtfully referred to this genus was accompanied by the following data: From *Spondias mombin* L. Elevation about 50 meters. It is uncertain from an examination of the insect whether this minute form is a gall-making or a predacious midge.

# REVIEWS

The | Medical Clinics | of | North America | September, 1919, | published bi-monthly by | W. B. Saunders Company | Philadelphia and London | Paper, pp. 279–549.

The New York Number, Volume 3, No. 2, contains the following papers:

Cerebral and spinal manifestations of purpura hæmorrhagica, by Dr. Warfield T. Longcope.

Cystitis: discussion regarding its therapy, by Dr. Leo Buerger.

Common disorders of childhood, by Dr. G. R. Pisek.

The symptoms and treatment of retention of waste products in nephritis, by Dr. Herman O. Mosenthal.

Recurring meningococcic meningitis, by Drs. W. W. Herrick and A. M. Dannenberg.

The value of chemical blood examinations in diagnosis, prognosis, and treatment of some constitutional conditions, by Dr. Arthur F. Chace.

Radium therapy, by Dr. George Stuart Willis.

Cholelithiasis, by Drs. M. A. Rothschild and A. O. Wilensky.

The functional diagnosis of the heart, by Dr. Morris H. Kahn.

The flint murmur, by Dr. Albert R. Lamb.

Vagotonia and sympathicotonia as aids in the diagnosis and treatment of endocrine conditions, by Dr. A. S. Blumgarten.

Physical therapy in locomotor ataxia, by Dr. Heinrich F. Wolf.

A discussion on the splenomegalies, by Dr. I. W. Held.

The | Petroleum Handbook | by | Stephen O. Andros, A. B., B. Sc., E. M. | [three lines of titles] | Chicago | The Shaw Publishing Company | 910 S. Michigan Blvd. | 1919 | 16 unnumbered pages + 1–206, illustrated; limp leather; price, $2.

### FROM THE PREFACE

There are many publications which treat separately of one or more phases of the petroleum industry, but none which gives the fundamentals of each and eliminates descriptions unnecessary to a clear understanding of the various operations entailed between the location of an oil well and the distribution of refined petroleum products to the consumer. There is very little original matter in the book. The sources of compilation are numerous; they comprise the bulletins of the United States Geological Survey; the bulletins of the United States Bureau of Mines; the reports of the various State Geological Surveys, notably those of Illinois, Kansas, and Texas; and standard text books on the subject, chief among which is the work of Bacon and Hamor.

**A Manual** | of | Obstetrics | by | John Cooke Hirst, M. D. | [six lines of titles] | with 216 illustrations | Philadelphia and London | W. B. Saunders Company | 1919 | Cloth, $3 net | pp. 1–516, including index.

PREFACE

This book is written as a companion to the author's Manual of Gynecology. It also presents, as far as possible on the printed page, the methods of teaching the subject he has used with satisfaction for the last twenty years. Throughout the book an effort has been made to present the subject clearly and concisely, and to avoid all unprofitable discussion. The methods of treatment and technic of operations advocated have all been tested in practice and have given satisfactory results.

The scope of the book has been rather sharply limited. A minimum of embryology has been included. Diseases of the newborn child are included only in so far as they occur during the puerperium. The chapters on lacerations of the birth-canal and consequences of childbirth, while differing somewhat in scope, are necessarily very similar to the same chapters in the Manual of Gynecology.

A new classification of deformities of the pelvis is presented, classifying them according to their most prominent deformity. This method has been found easier for the student to remember, and simplifies the discussion of their management.

Especial care has been given to the description of the mechanism of labor, with a view to simplifying this, to the student, most puzzling subject. The illustrations in this chapter have been chosen with the idea of enabling him to visualize the different presentations, a thing most essential in the proper application of forceps.

The longest chapter is that on the obstetric operations. Especial care has been given to a somewhat extensive description of that most dangerous of all obstetric instruments, the forceps. The different operations are all detailed, with indications, contraindications and the steps of their performance.

The entire subject of obstetric hemorrhage is to be found in one chapter, with precise directions as to management.

This book, like the Manual of Gynecology, is presented with the hope that it will be found useful by both medical student and practitioner, whose time for voluminous reading is limited.

**Commercial Research** | **An Outline of Working Principles** | **by** | C. S. Duncan, Ph. D. | [three lines of titles] | New York | The Macmillan Company | 1919 | Cloth, pp. i–ix + 1–385.

FROM THE PREFACE

The theory of this book can be simply stated; it falls readily into a series of propositions which have guided the writer from first to last in the composition:

1. The immediate and primary need of business to-day is intelligent direction and control, individually, generally.
2. Intelligent direction and control of business can be had only by a better knowledge of business principles.
3. A better knowledge of business principles can be derived only from a careful and comprehensive survey of business facts.
4. To secure a careful and comprehensive survey of business facts is a problem for business research.
5. Therefore, the immediate and primary need of business to-day can be met only by business research.

This means, also, that the research work so well begun in the field of production should be carried over into trade, into buying and selling. The beginning and the end of every business enterprise is a marketing problem. The problems of marketing, therefore, like factory problems, must be isolated, abstracted, analyzed after the scientific method. More deliberate, concentrated, prolonged and undisturbed thinking ought to be applied to business problems. They are of vital importance to success; they are fascinatingly interesting in themselves; their very difficult complexity is a stimulating intellectual challenge; the rewards which their correct solution offers have no determinable limit.

**Syphilis** | A Treatise on Etiology, Pathology, | Diagnosis, Prognosis, Prophylaxis, | and Treatment | by | Henry H. Hazen, A. B., M. D. | [ten lines of titles] | with 160 illustrations including 16 figures | in colors | St. Louis | C. V. Mosby Company | 1919 | Cloth, pp. 7–647 including index, $6.00.

FROM THE PREFACE

At the present time there exists no small book that covers the whole field of syphilis in an authoritative way. To know syphilis means to know the entire domain of medicine, and for any one man this is impossible. In the preparation of this work I have been fortunate in being able to induce various men to write special chapters for me. Many other friends and acquaintances have aided in various ways, either with illustrations or advice, and to them I give my thanks, for much of the best in this book is due to others.

**The Woman** | **of Forty** | by | Edith B. Lowry, M. D. | Author of "Herself," "Himself," etc. | Chicago | Forbes & Company | 1919 | Cloth, pp. i–viii + 9–203 including index.

**Modern Surgery** | general and operative | by | John Chalmers Da Costa, M. D., LL. D., F. A. C. S. | [ten lines of titles] | eighth edition, revised, enlarged, and reset | with 1,177 illustrations, some of them in colors | Philadelphia and London | W. B. Saunders Company | 1919 | Cloth, pp. 11–1697 including index.

**A Text-book** | **upon the** | **Pathogenic Bacteria** | **and Protozoa** | for students of medicine and physicians | by | Joseph McFarland, M. D., Sc. D. | [two lines of titles] | Ninth edition, revised | with 330 illustrations | a number in colors | Philadelphia and London | W. B. Saunders Company | 1919 | Cloth, 1–858 pp. including index.

THE PHILIPPINE
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# NEW OR NOTEWORTHY PHILIPPINE PLANTS, XVI

By ELMER D. MERRILL

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The sixteenth paper of this series is essentially like its predecessors, the last number having been published in 1919.[1] The present paper contains the descriptions of about one hundred presumably hitherto undescribed species of flowering plants, with some notes on nomenclature and some proposed changes in generic and specific names, as well as the records for a few species previously described from extra-Philippine material now found for the first time in the Archipelago. The genera *Fibraurea* of the Menispermaceae, *Phyllochlamys* of the Moraceae, *Eurycoma* of the Simarubaceae, and *Ixonanthes* of the Linaceae are new to the Philippine flora, the last two being represented by previously undescribed species.

A large number of the new species described in the present paper is from the eastern coast of Surigao Province, Mindanao, and the neighboring islands of Dinagat, Siargao, and Bucas Grande, regions in which no intensive botanical collecting has hitherto been done. Extensive collections were made in these regions by Messrs. M. Ramos and J. Pascasio, April to June, 1919; and, as is usual in previously unexplored regions in the Philippines, their material contains a high percentage of previously undescribed species. Doubtless any general collection made in the same regions, but at a different time of the year, would yield an equally high percentage of novelties.

[1] Merrill, E. D., New or noteworthy Philippine Plants, XV, Philip. Journ. Sci. 14 (1919) 365–457.

## PANDANACEAE

### PANDANUS Linnaeus f.

**PANDANUS APICULATUS** sp. nov. § *Rykia.*

Arbor, circiter 5 m alta, ramulis 2.5 ad 3 cm diametro; foliis circiter 1 m longis et 5.5 cm latis, in siccitate subflaccidis, sursum angustatis, apice tenuiter acuminatis, inter nervis transversalibus distincte reticulatis; infructescentiis lateralibus, 10 ad 15 cm longis, syncarpiis spicatim dispositis, plerumque 10, confertis, ovoideis ad globosis, 15 cm diametro; drupis numerosis, confertis, cylindricis vel oblongis, 1-locellatis, 6 ad 7 mm longis, 2 ad 2.5 mm diametro, apice rotundatis et acute apiculatis, stylis circiter 1 mm longis.

A tree, about 5 m high, the ultimate branches 2.5 to 3 cm in diameter. Leaves about 1 m long and 5.5 cm wide, somewhat flaccid when dry, the margins armed with rather conspicuous teeth, the midrib beneath near the base with retrorse teeth and toward the apex with antrorse teeth, the 2 lateral nerves sometimes with a few scattered teeth on the upper surface near the apex, the blade more or less narrowed to the distinctly and rather slenderly acuminate apex, distinctly transversely reticulate between the numerous secondary nerves. Infructescences lateral, from the base of the apical tufts of leaves, 10 to 15 cm long, the syncarps ovoid to globose, sessile, about 1.5 cm in diameter, usually about 10 on each infructescence, the peduncles closely covered in the lower half with numerous, imbricate, spirally arranged, oblong bracts, which are usually about 4 cm in length. Drupes numerous, crowded, red, cylindric or oblong or sometimes narrowed below, 1-celled, 6 to 7 mm long, 2 to 2.5 mm in diameter, the apical 1.5 to 2 mm free, rounded, terminated by the indurated, slightly upward-curved, usually acute style, which is usually about 1 mm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34572 Ramos & Pascasio,* April 25, 1919, on ridges, altitude about 690 meters, at the iron deposit on the northeast coast.

A rather remarkable species on account of its lateral infructescences and its multibracteate peduncles. It is manifestly allied to *Pandanus multibracteatus* Merr., but has much wider leaves and differs essentially in its fruit characters, the drupes being much smaller and not prolonged into slender, elongated tips, as in the latter species.

**PANDANUS DINAGATENSIS** sp. nov. § *Rykia.*

Frutex parvus, ramulis circiter 3 cm diametro; foliis usque ad 1.75 m longis, circiter 6.5 cm latis, subcoriaceis, sursum angustatis, acuminatis; infructescentiis plerumque 3, pedunculatis, syncarpiis circiter 10, spicatim dispositis, oblongo-ovoideis ad anguste oblongis, 2 ad 4 cm longis, confertis, pedunculo usque ad 10 cm longo; drupis minutis, confertis, oblongis, 1-locellatis, 5 ad 6 mm longis, usque ad 2 mm diametro, apice rotundatis vel conicis, stigma plerumque rotundata et circiter 1 mm diametro.

A small shrub, the ultimate branches about 3 cm in diameter. Leaves up to 1.75 m long, about 6.5 cm wide, subcoriaceous, the margins armed with small teeth, the midrib beneath in the upper part with small scattered teeth, more or less narrowed above to the acuminate apex. Syncarps about 10, spicately arranged on each peduncle, oblong-ovoid to narrowly oblong, 2 to 4 cm long, 1.5 to 2 cm wide, crowded toward the upper tips of the peduncles, usually 3 or more infructescences terminating each branchlet, the peduncles up to 10 cm long and 5 to 7 mm in diameter. Drupes very numerous, crowded, oblong or somewhat narrowed below, 1-celled, 5 to 6 mm long, 2 mm in diameter or less, their apices somewhat rounded or conical, terminated by the flattened and rounded or sometimes papilliform stigma which is usually less than 1 mm in diameter.

DINAGAT, *Bur. Sci. 35183 Ramos & Pascasio,* May 12, 1919, in forests along streams at low altitudes.

A species remarkable for its numerous, small, crowded syncarps and for the very unusual character of several peduncles terminating each branchlet. The species is further characterized by its very small drupes, and is not closely allied to any previously described form.

**PANDANUS MULTIBRACTEATUS** sp. nov. § *Acrostigma.*

Arbor, circiter 4 m alta, ramulis circiter 3.5 cm diametro; foliis rigidis, coriaceis, anguste acuminatis, 1.5 ad 2 m longis, 3 ad 3.5 cm latis; infructescentiis lateralibus, spicatis, pedunculo usque ad 10 cm longo, bracteis numerosis spiraliter dispositis, oblongis, 2 ad 3 cm longis, obtecto; syncarpiis 8 ad 10, confertis, ovoideis, 1.5 ad 2.5 cm longis, drupis numerosis, usque ad 3 mm diametro, confertis, stylis tenuibus, rigidis, integris vel obscure dentatis, circiter 5 mm longis.

A small tree, about 4 m high, the ultimate branches about 3.5 cm in diameter. Leaves coriaceous, rigid, 1.5 to 2 m long, 3 to 3.5 cm wide, the margins armed with short, sharp, rather closely arranged teeth, gradually narrowed upward to the slenderly acuminate apex. Infructescences lateral, from the branches below the leaves, the peduncles up to 10 cm in length, densely covered by spirally arranged, very numerous, imbricating, coriaceous, rigid, oblong, entire or slightly toothed bracts, 2 to 3 cm in length. Syncarps 8 to 10, red, spicately arranged, rather crowded, ovoid, 1.5 to 2.5 cm long, composed of numerous, densely arranged, 1-celled drupes which are 3 mm or less in diameter, their apices abruptly narrowed, somewhat ridged, terminated by the slender, entire or slightly toothed, rigid, straight or somewhat curved styles which are up to 5 mm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34571* (type), *34819 Ramos & Pascasio,* April 25, 1919, at the iron deposit on the northeast coast on the Hegapit River, altitude about 680 meters. The fruit red when mature.

A remarkable species, not closely allied to any previously described Philippine form and easily recognizable by its lateral, spicate inflorescences; by its small, ovoid syncarps, the tips of the drupes narrowed and elongated; and by the multibracteate peduncles.

**PANDANUS RAMOSII** sp. nov. § *Bryantia.*

Frutex, 2 ad 3 m altus, ramulis ultimis circiter 1.5 cm diametro; foliis crasse coriaceis, linearis, circiter 1.5 m longis, 2 ad 2.5 cm latis, apice tenuiter acuminatis; syncarpiis terminalibus, erectis, solitariis, ovoideis, 5 ad 6 cm longis, pedunculo usque ad 20 cm longo, circiter 7 mm diametro; drupis numerosis, 1-locellatis, 10 ad 12 mm longis, circiter 3 mm diametro, anguste oblongis, ½ superioribus liberis, rotundatis, stigma sessile, planum, circiter 1.3 mm diametro.

A shrub, 2 to 3 m high, the ultimate branches about 1.5 cm in diameter. Leaves thickly coriaceous, rigid, rather pale when dry, linear, about 1.2 m long, 2 to 2.5 cm wide, narrowed above to the rather slender, acuminate apex, the margins distinctly toothed, the midrib on the lower surface in the upper part more or less toothed as are the 2 primary veins on the upper surface toward the apex. Syncarps terminal, erect, solitary, ovoid, 5 to 6 cm long, somewhat triangular in cross section, the basal part somewhat inclosed by a few, broadly ovate, leaflike bracts, the peduncles up to 20 cm long, triangular, about 7 mm in diameter, supplied with 2 or 3 reduced leaves 25 to 40 cm in length in addition to the terminal, leaflike bracts. Drupes very numerous, crowded, red, 1-celled, 10 to 12 mm long, about 3 mm in diameter, narrowly oblong, the apical half free, somewhat angular, rather abruptly rounded or narrowed at the apex and terminated by the flat, sessile, truncate stigma, which is usually about 1.3 mm in diameter.

BUCAS GRANDE, *Bur. Sci. 35136 Ramos & Pascasio,* June 10, 1919, in dry forests at low altitudes. The same species is apparently represented by *Bur. Sci. 35198 Ramos & Pascasio* from the neighboring island of Dinagat, the latter number consisting of leaves only.

A species not closely allied to any previously described Philippine form, well characterized by its narrow, rigid leaves; its solitary, erect, long-peduncled syncarps, the peduncles being supplied with several reduced leaves and several additional, reduced, apical, leaflike bracts; and by its very numerous, small, narrow, 1-celled drupes. Allied to *Pandanus brachyspathus* Martelli, but with very different leaves.

**PANDANUS TENUIPEDUNCULATUS** sp. nov. § *Bryantia.*

Frutex erectus, ramulis 1 ad 1.3 cm diametro; foliis subflaccidis, anguste oblongo-lanceolatis, 50 ad 75 cm longis, 3 ad 4.5 cm latis, apice abrupte angustatis, breviter acuminatis; syncarpiis ovoideis, erectis, circiter 3 cm diametro, pedunculo usque ad 9 cm longo, 5 mm diametro; drupis numerosis, obovoideis ad anguste obovoideis, 10 ad 12 mm longis, circiter 5 mm diametro, 1-locellatis, apice rotundatis, stigma sessile, planum, circiter 1.2 mm diametro.

A shrub, the ultimate branches 1 to 1.3 cm in diameter. Leaves subflaccid, narrowly oblong-lanceolate, 50 to 75 cm long, 3 to 4.5 cm wide, about the same width throughout or somewhat narrowed below, the apex abruptly tapering to the short acumen, the latter 5 mm long or less, the margins rather finely toothed, the midrib beneath in the uppermost part with few small teeth, the 2 lateral nerves on the upper surface toward the apex with similar scattered teeth. Heads ovoid, solitary, terminal, erect, about 3 cm in diameter, the peduncles triangular, about 9 cm long, 5 mm in diameter. Drupes red, obovoid to narrowly obovoid, 10 to 12 mm long, up to 5 mm in diameter, 1-celled, narrowed below to the cuneate base, the apical portion rounded, the very tip sometimes depressed, terminated by the flat stigma which is about 1.2 mm in diameter.

MINDANAO, Surigao Province, *Bur. Sci. 34739 Ramos & Pascasio,* June 20, 1919, in open forests at low altitudes. *Bur. Sci. 34842 Ramos & Pascasio* from Siargao Island, a specimen with staminate flowers, probably represents the same species.

This species is readily distinguishable by its rather flaccid leaves which are of about the same width throughout and rather abruptly narrowed to the short-acuminate apex; and by its slenderly peduncled, solitary, erect syncarps.

## PIPERACEAE

### PIPER Linnaeus

**PIPER ANGUSTIPELTATUM** sp. nov. § *Eupiper.*

Frutex dioicus, scandens, glaber; foliis oblongis, nitidis, 10 ad 16 cm longis, aequilateralibus, chartaceis, basi rotundatis et anguste peltatis, 7-nerviis, apice perspicue acuminatis; spicis ♀ cylindricis, circiter 3 cm longis et 12 mm diametro, bracteis peltatis, glabris, stylis tenuibus, patulis, confertis, 3 ad 4 mm longis.

A glabrous, dioecious vine, the ultimate branches terete, about 2 mm in diameter. Leaves chartaceous, oblong, 10 to 16 cm long, 3 to 6 cm wide, equilateral or nearly so, the base rounded and narrowly peltate, the petioles inserted, 2 to 4 mm from the edge of the leaf, 7-nerved, the inner pair of nerves extending to the apex, the reticulations horizontal, distinct, subparallel, the apex rather prominently acuminate, both surfaces shining when dry; petioles 2 to 2.5 cm long. Pistillate spikes, leaf-opposed, cylindric, about 3 cm long and 12 mm in diameter, their peduncles up to 2 cm in length; bracts peltate, rounded, 0.8 mm in diameter, styles numerous, densely crowded, spreading, slender, 3 to 4 mm long. Stigmas 2, recurved, 0.5 mm long.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28846 Ramos & Edaño,* May 19, 1917, in damp forests along rivers at low and medium altitudes.

This species is similar and very closely allied to *Piper longistigmum* C. DC. from which it is easily distinguished by its narrowly peltate leaves.

**PIPER CATUBIGENSE** sp. nov. § *Eupiper.*

Frutex dioicus, scandens, foliis subtus ad costa nervisque pubescens; foliis penninerviis, membranaceis, lanceolatis ad oblongo-ovatis, 15 ad 17 cm longis, basi obtusis ad rotundatis, leviter inaequilateralibus, apice tenuiter acuminatis, nervis utrinque circiter 9, distinctis; spicis ♂ cylindricis, tenuibus, 5 ad 7 cm longis, circiter 3 mm diametro, bracteis peltatis.

A scandent, dioecious vine, the branchlets, petioles and leaves along the midrib and nerves on the lower surface distinctly pubescent. Leaves membranaceous, lanceolate to oblong-ovate, penninerved, 15 to 17 cm long, 4 to 9 cm wide, the base obtuse or rounded and slightly inequilateral, the apex slenderly acuminate; lateral nerves about 9 on each side of the midrib, distinct, ascending, somewhat curved; petioles 10 to 12 mm long. Staminate spikes cylindric, rather slender, black when dry, 5 to 7 cm long, about 3 mm in diameter, their peduncles 10 to 12 mm in length, sparingly pubescent. Bracts peltate, about 1 mm in diameter. Anthers apparently 2.

SAMAR, Catubig River, *Bur. Sci. 24278 Ramos,* March 13, 1916, on trees in damp forests at low altitudes.

A species belonging in the group with *Piper pennínerve* C. DC. and most closely allied to *Piper longilimbum* C. DC., from which it is distinguished by its smaller, caudate-acuminate leaves and by its staminate spikes being but half as long as in the latter species.

PIPER ELMERI sp. nov. § *Eupiper.*

Frutex dioicus, scandens, ramis circiter 1 cm diametro; foliis chartaceis ad subcoriaceis, late ovatis, aequilateralibus, basi profunde cordatis, 10- vel 12-plinerviis, apice acutis vel acuminatis, usque ad 30 cm longis, subtus molliter pubescens; spicis ♂ usque ad 25 cm longis, circiter 4 mm diametro, bracteis pubescens, peltatis, 2.5 ad 3.5 mm longis; spicis ♀ usque ad 25 cm longis, cylindricis, densis; fructibus pedicellatis, ovoideis, 7 ad 9 mm longis, pedicellis usque ad 1.5 cm longis.

A coarse, woody, dioecious vine, the branches up to 1 cm in diameter, the older ones somewhat angled, rugose and brownish when dry. Leaves chartaceous to subcoriaceous, broadly ovate, 15 to 30 cm long, 11 to 23 cm wide, equilateral or nearly so, the base deeply cordate, 10- or 12-plinerved, the sinus rather narrow up to 4 cm deep, the basal lobes broadly rounded, apex acute or somewhat acuminate, the upper surface glabrous, shining, olivaceous, the lower surface softly pubescent; nerves prominent, the reticulations distinct; petioles up to 6 cm in length. Inflorescences simple, leaf-opposed, the staminate ones up to 25 cm long, about 4 mm in diameter, their peduncles 1.5 to 2 cm long. Staminate flowers numerous, the stamens 2, about 2 mm long, the bracts peltate, oblong-ovate, obtuse, pubescent, 2.5 to 3.5 mm long. Pistillate inflorescences up to 20 cm long or in fruit up to 25 cm in length, the rachis rather stout, cylindric, about 5 mm in diameter, the flowers numerous, crowded, sessile or subsessile, the ovary ovoid to elliptic, glabrous, about 2 mm long, the stigmas 3 or 4, sessile, the pedicels increasing in length immediately after anthesis and in fruit up to 1.5 cm long, spreading, the fruits ovoid, yellowish-red when fresh, somewhat wrinkled and usually black when dry, 7 to 9 mm long, the rachis with numerous unfertilized flowers in addition to those which develop into fruits.

SAMAR, Catubig River, *Bur. Sci. 24256 Ramos* (type), February 10, 1916. LUZON, Sorsogon Province, Mount Pokdal, *Bur. Sci. 23490 Ramos,* August 3, 1915, with staminate flowers and the local Bikol name *buyong halas:* Laguna Province, Mount Maquiling, *For. Bur. 26751 Mabesa,* March, 1917, *Elmer 18059,* June, 1917. In damp forests at low and medium altitudes, ascending to 450 meters on Mount Maquiling.

A remarkable species not at all resembling any previously described form, easily recognizable by its broadly ovate, deeply cordate, equilateral leaves which are softly pubescent beneath; by its rather stout, cylindric, elongated spikes and their pubescent bracts; and by its large, long-pedicelled fruits.

## ULMACEAE

### CELTIS Linnaeus

**CELTIS ASPERIFOLIA** sp. nov.

Arbor magna, plus minusve pubescens; foliis tenuiter chartaceis, scaberulis, ovatis, integris, 5 ad 8 cm longis, acuminatis, basi inaequilateralibus, 3-nerviis, oblique truncatis ad rotundatis vel acutis; inflorescentiis pubescens, usque ad 5 cm longis, inferioribus ♂ superioribus , sepalis et staminibus 5, ovario pubescente.

A tree, about 25 m high, more or less pubescent. Leaves thinly chartaceous, rather scabrous, both surfaces with scattered, very short hairs, ovate, entire, 5 to 8 cm long, 3 to 5 cm wide, the base inequilateral, 3-nerved, somewhat oblique-truncate to rounded or even shallowly cordate, the younger leaves sometimes acute, apex acuminate; nerves slender, including the basal pair usually 3 on each side of the midrib; petioles pubescent, about 5 mm long. Inflorescences axillary and from the axils of fallen leaves, the latter usually wholly staminate, the former with both male and perfect flowers, cinereous-pubescent, up to 5 cm long. Male flowers sessile, somewhat glomerate on the branchlets, 5-merous, about 4 mm in diameter, the sepals distinctly pubescent, oblong-obovate, 2 mm long. Stamens equaling the sepals. Perfect flowers fewer than the male, sessile or short-pedicelled, the sepals 5, elliptic to oblong-elliptic, 2 to 2.5 mm long. Ovary oblong-ovoid, pubescent, the style arms forked. Stamens 5, filaments 2 mm long.

MINDANAO, Davao Province, Santa Cruz, *For. Bur. 27562 De Mesa,* May 2, 1919, in sandy soil, altitude about 70 meters, with the local Tagakaolo name *sikím.*

This species does not appear to be very closely allied to any previously described form. It is easily distinguished among the Oriental species with entire leaves by its indumentum and its scabrous leaves. The collector gives the height of the tree as 25 meters with a trunk diameter of 1 meter.

## MORACEAE

### PHYLLOCHLAMYS Bureau

**PHYLLOCHLAMYS TAXOIDES** (Heyne) Koord. Exkursionsfl. Java 2 (1912) 89, var. **PARVIFOLIA** var. nov.

A rigid, branched, spiny shrub, 1 to 3 m high, entirely glabrous. Leaves chartaceous, oblong to elliptic-oblong or oblong-lanceolate, entire or with one or two teeth near their tips, acute to slightly acuminate, 2 to 4 cm long, 1 to 2.3 cm wide, the nerves not prominent. Pistillate flowers solitary, their pedicels about 4 mm long, each with a pair of bracteoles at about the middle, these ovate, obtuse, about 1 mm long. Sepals 4, in anthesis 4 to 8 mm long, lanceolate to oblong-lanceolate, not reticulate, slenderly acuminate, pale-green when fresh.

PALAWAN, Lake Manguao, *Merrill 9482*, April 27, 1913, on steep, dry, forested banks, altitude about 70 meters.

This is the first record for *Phyllochlamys* as Philippine, the form above described differing from the typical Indian *P. taxoides* (Heyne) Koord. (*P. spinosa* Bureau) in its much smaller, not prominently nerved, entire or only slightly toothed leaves. It may ultimately prove to be specifically distinct, as it is rather different from the single Indian specimen I have for examination, *Wight 817*. The species is widely distributed in India, but is reported from the Malay Archipelago only from Timor.

## PROTEACEAE

### HELICIA Loureiro

**HELICIA PAUCINERVIA** sp. nov.

Arbor parva glabra; foliis coriaceis, oblongo-ellipticis, utrinque angustatis, basi acutis vel leviter decurrentibus, apice obtusis vel obtuse acuminatis, usque ad 14 cm longis, sursum distanter dentatis, vel integris, pagina superiore valde nitidis, nervis utrinque circiter 5, perspicuis; racemis lateralibus, e axillis defoliatis, circiter 20 cm longis; floribus solitariis vel binis, 2 cm longis.

A glabrous tree, about 5 m high, the branches dark reddish-brown. Leaves coriaceous, oblong-elliptic, narrowed to the acute or somewhat decurrent base and to the obtuse or bluntly acuminate apex, 10 to 14 cm long, 4.5 to 6 cm wide; the margins distantly and rather coarsely toothed above or sometimes entire, the upper surface brownish-olivaceous, strongly shining, the lower surface dull, paler; lateral nerves about 5 on each side of the midrib, prominent; petioles about 1 cm long. Racemes solitary, lateral, in the axils of fallen leaves, about 20 cm long. Flowers white, solitary or paired, 2 cm long, their pedicels 2 to 3 mm long, when in pairs free nearly to the base. Perianth lobes 4, the somewhat enlarged tips narrowly oblong, about 3 mm long and 1.2 mm wide. Hypogynous scales more or less united into a prominent white disk about 1 mm high.

MINDANAO, Surigao Province, *Bur. Sci. 34610 Ramos & Pascasio*, April 25, 1919, on river banks at the iron deposit on the northeast coast, altitude about 300 meters.

A species closely allied to *Helicia oligophlebia* Merr. but with larger leaves and flowers. It is possible that *Bur. Sci. 34621 Ramos & Pascasio* from the same locality represents the same species. This specimen, however, is in fruit, and the leaves are relatively narrower and are wholly entire.

## ARISTOLOCHIACEAE

### BRAGANTIA Loureiro

**BRAGANTIA BREVIPES** sp. nov.

**Suffrutex simplex, erectus, 0.5 m altus, leviter pubescens; foliis subcoriaceis, oblongo-ellipticis ad elliptico-ovatis, 11 ad 17 cm longis, basi obtusis ad rotundatis, 3-nerviis, apice obtusis ad rotundatis, plerumque minute apiculatis, breviter petiolatis, petiolo 5 ad 8 mm longo; racemis basilaribus, solitariis, 4 ad 12 cm longis, bracteis lineari-lanceolatis; floribus circiter 12 mm diametro, hirsutis, lobis late ovatis, reticulatis; capsulis tenuis, leviter torulosis, circiter 4 cm longis et 4 mm diametro.**

An erect, small undershrub, up to 50 cm high, the stems sulcate when dry, grayish, 5 mm in diameter or less, solitary or 2 or 3 from the same root, more or less cinereous-pubescent as are the leaves on the lower surface. Leaves subcoriaceous, grayish or olivaceous when dry, oblong-elliptic to elliptic-ovate, 11 to 17 cm long, 6 to 10 cm wide, base rounded to obtuse, 3-nerved, the apex rounded or obtuse and usually minutely apiculate; lateral nerves above the basal pair about 5 on each side of the midrib, ascending, distinct on the lower surface as are the close reticulations; petioles 5 to 8 mm long. Racemes basal, solitary, the rachis 4 to 12 cm long, the bracts linear-lanceolate, pubescent, about 7 mm in length. Flowers about 12 mm in diameter, somewhat hirsute, yellowish, the perianth tube broadly cup-shaped or ovoid, about 4 mm long, the limb spreading, the lobes broadly ovate, reticulate, 6 mm long and 8 mm wide, stamens 6, free, the filaments about 1 mm in length. Capsules slender, somewhat torulose when dry, about 4 cm long and 4 mm in diameter.

MINDANAO, Surigao Province, *Bur. Sci. 34811* (type), *34369 Ramos & Pascasio,* April and May, 1919, in forests along small streams at low altitudes. To this species I also refer *Merrill 10490* from Alabat and *Bur. Sci. 13370 Ramos* from Tayabas Province, Luzon, both of which were originally identified as *Bragantia affinis* Planch.

The alliance of this species is manifestly with *Bragantia affinis* Planch., a species definitely known only from Panay. It is distinguished from the latter especially by its much shorter petioles.

## MENISPERMACEAE

### FIBRAUREA Loureiro

**FIBRAUREA CHLOROLEUCA** Miers in Ann. Nat. Hist. III 13 (1864) 489; Diels in Engl. Pflanzenreich 46 (1910) 120, *f. 43.*

DINAGAT, *Bur. Sci. 35224, 35229 Ramos & Pascasio,* May 12, 1919, in forests along small streams at low altitudes.

This is the first record of this genus as Philippine, the specimens cited above coming well within the range of variation of Miers's species as represented by ample material before me from Borneo, Sumatra, Java, and the Malay Peninsula, although the inflorescences are 30 cm in length; the longest inflorescence on the extra-Philippine material available for comparison is 25 cm, while Diels gives the maximum as 20 cm. The species extends from Burma, through Malaya, to Celebes.

## MAGNOLIACEAE

### TALAUMA Jussieu

**TALAUMA RETICULATA** sp. nov.

Arbor glabra, pedunculis ramulisque exceptis glabra; foliis anguste oblongis ad oblongo-oblanceolatis, 24 ad 34 cm longis, 5 ad 7.5 cm latis, crasse coriaceis, nitidis, deorsum angustatis, basi cuneatis, apice acutis vel breviter acuminatis, nervis utrinque circiter 14, cum reticulis valde perspicuis; carpellis ut videtur paucis 1.5 ad 3 cm longis, 1 ad 1.5 cm latis, obtusis, haud rostratis.

A small tree, glabrous except the peduncles and very young branchlets, the latter about 5 mm in diameter. Leaves narrowly oblong to oblong-oblanceolate, 24 to 34 cm long, 5 to 7.5

cm wide, thickly coriaceous, shining, narrowed below to the cuneate base and above to the acute or shortly acuminate apex; lateral nerves about 14 on each side of the midrib, distant, anastomosing, prominent, the reticulations very distinct on both surfaces; petioles stout, about 2 cm long. Fruits solitary, their peduncles about 5 cm long, appressed-pubescent, the rachis of the infructescence 5 to 6 cm long, the individual carpels apparently few, brown when dry, 1.5 to 3 cm long, 1 to 1.5 cm wide, their tips blunt, not at all prolonged into a beak.

DINAGAT, *Bur. Sci. 35187 Ramos & Pascasio*, May 12, 1919, in forests at low altitudes.

This species in its vegetative character resembles *Talauma angatensis* F.-Vill., but has narrower, differently shaped, more conspicously reticulate leaves; it further differs from the latter species in its apparently few carpels which are merely blunt at their apices, not at all beaked.

## ANNONACEAE

### OXYMITRA Hooker f. and Thomson

**OXYMITRA OLIGOPHLEBIA** sp. nov.

Frutex scandens, ramulis floribusque exceptis glaber, ramis tenuibus; foliis chartaceis vel subcoriaceis, oblongis ad oblongo-lanceolatis, usque ad 10 cm longis, basi rotundatis, sursum angustatis, acutis vel leviter acuminatis, olivaceis, nitidis, subtus brunneis, nervis utrinque plerumque 5, tenuibus, distinctis; floribus extra-axillaribus, solitariis, circiter 3 cm longis, lanceolatis, ferrugineo-pubescens, longetenuiterque pedicellatis.

A scandent shrub, glabrous except the very slightly pubescent branchlets and the rather densely ferruginous-pubescent flowers; the branches terete, slender, about 3 mm in diameter, shining, dark reddish-brown when dry. Leaves firmly chartaceous or subcoriaceous, oblong to oblong-lanceolate, 6 to 10 cm long, 2 to 3.5 cm wide, the base rounded, narrowed upward to the acute or slightly acuminate apex, the upper surface olivaceous, shining, the lower surface brownish; lateral nerves usually 5 on each side of the midrib, slender, distinct, curved, the reticulations not prominent; petioles about 3 mm long. Flowers yellow, solitary, extra-axillary, about 3 cm long, lanceolate, acuminate, their pedicels up to 2.5 cm long, slender, sparingly pubescent with a small bract below the midrib. Calyx-lobes triangular-ovate, pubescent, acuminate, about 3 mm long. Outer petals when young densely ferruginous-pubescent, the indumentum more or less scattered in age.

BUCAS GRANDE, *Bur. Sci. 35068 Ramos & Pascasio*, June 10, 1919, in dry forests at low altitudes.

This species is probably more closely allied to *Oxymitra paucinervia* Merr. than to any other species, but differs in its fewer-nerved leaves which are not at all glaucous beneath.

GONIOTHALAMUS Hooker f. and Thomson

**GONIOTHALAMUS PANAYENSIS** sp. nov.

Arbor parva, ramulis junioribus et floribus plus minusve pubescens; foliis chartaceis vel subcoriaceis, oblongis, 15 ad 30 cm longis, basi acutis, apice tenuiter acuminatis, nervis utrinque circiter 12, perspicuis; floribus solitariis vel fasciculatis e truncis vel ramis majoribus, breviter pedicellatis, circiter 2.5 cm longis; petalis exterioribus lanceolatis, crasse coriaceis sursum angustatis, utrinque plus minusve pubescens; petalis interioribus circiter 1.3 cm longis, conniventibus.

A tree, about 5 m high, the very young branchlets sparingly pubescent, the flowers usually densely so, otherwise glabrous. Leaves chartaceous or subcoriaceous, oblong, shining, 15 to 30 cm long, 4 to 10 cm wide, the base acute, apex slenderly acuminate; lateral nerves about 12 on each side of the midrib, prominent, the reticulations rather lax, distinct; petioles 1 to 2 cm long. Flowers yellowish, solitary or fascicled on the trunk and larger branches, rarely axillary on the younger branches, their pedicels densely pubescent, about 4 mm long, usually subtended by a pair of small bracts. Calyx about 1.3 cm in diameter, the lobes ovate, acute or somewhat acuminate, more or less pubescent. Outer 3 petals lanceolate, apparently fleshy, thickly coriaceous when dry, about 2.5 cm long and 8 mm wide, narrowed upward to the acute or slightly acuminate apex, slightly constricted toward the base, both surfaces more or less pubescent with short, appressed, shining, brownish hairs. Inner petals about 1.3 cm long, appressed-pubescent, connivent.

PANAY, Capiz Province, Libacao and Mount Salibongbong, *Bur. Sci. 35290* (type), *35575 Martelino & Edaño*, June, 1919, in forests.

This species is distinctly allied to *Goniothalamus amuyon* (Blanco) Merr., from which it is readily distinguished by its larger, slenderly acuminate leaves, and smaller flowers.

PSEUDUVARIA Miquel

**PSEUDUVARIA CAUDATA** sp. nov.

Arbor parva, dioeca, partibus junioribus floribusque exceptis glabra, ramis tenuibus; foliis lanceolatis, 5 ad 14 cm longis, nitidissimis, basi acutis, apice caudato-acuminatis, nervis utrinque 7 ad 10, perspicuis; floribus axillaribus, petalis exterioribus late ovatis, obtusis, 2.5 mm longis, interioribus arcuatis, 8 ad 9 mm longis; staminibus circiter 40.

A tree, about 7 m high, glabrous except the younger parts and the flowers. Branches slender, terete, nearly black when dry, glabrous, the branchlets sparingly pubescent. Leaves lanceolate, 6 to 14 cm long, 1.5 to 3.5 cm wide, chartaceous, strongly shining when dry, base acute, narrowed upward to the slenderly caudate-acuminate apex, the lower surface slightly pubescent on the midrib; lateral nerves 7 to 10 on each side of the midrib, prominent, curved-ascending, anastomosing; petioles 3 to 5 mm long. Flowers axillary, greenish, solitary or in pairs, their pedicels 7 to 10 mm long, finely pubescent, bearing a small bract at the middle 1 mm long or less and wider than long. Sepals broadly ovate, rounded, pubescent, about 1.8 mm in diameter. Outer 3 petals broadly ovate, rounded or obtuse, pubescent, about 2.5 mm long; inner 3 petals arched, 8 to 9 mm long, pubescent; the limb 5 mm wide, 2 to 3 mm long, the claw 5 to 6 mm in length. Stamens about 40, densely crowded, less than 1 mm long.

LUZON, Camarines Province, Sipocot, *For. Bur. 25533 Cenabre*, May 15, 1916, on forested slopes, altitude about 80 meters.

A species well characterized in this small genus by its lanceolate, caudate-acuminate leaves. The specimen presents only male flowers.

### POPOWIA Endlicher

**POPOWIA LANCEOLATA** sp. nov.

Arbor parva, ramis tenuibus, glabris, ramulis ferrugineo-pubescens; foliis chartaceis vel subcoriaceis, lanceolatis, 4 ad 6 cm longis, 1 ad 1.5 cm latis, utrinque subaequaliter angustatis, basi cuneatis, apice tenuiter acuminatis, supra glabris, subtus ad costa nervisque adpresse pubescens; nervis utrinque plerumque 5, tenuibus, adscendentibus, reticulis obsoletis; fructibus globosis circiter 8 mm diametro.

A tree, about 8 m high, the branches and branchlets terete, the former glabrous, nearly black when dry, slender, the latter more or less ferruginous-pubescent. Leaves lanceolate, firmly chartaceous or subcoriaceous, 4 to 6 cm long, 1 to 1.5 cm wide, subequally narrowed to the cuneate base and to the rather slenderly acuminate apex, the upper surface glabrous, the lower surface paler and appressed-pubescent on the midrib and nerves; lateral nerves slender, ascending, usually 5 on each side of the midrib, the reticulations obsolete; petioles about 2 mm long. Very young flowers in axillary, short, few-flowered cymes, the pedicels, sepals, and petals ferruginous-pubescent. Fruits globose, sparingly pubescent, about 8 mm in diameter.

DINAGAT, *Bur. Sci. 35186 Ramos & Pascasio,* May 12, 1919, in forests at low altitudes.

A species manifestly allied to *Popowia polyandra* (Presl) Merr., which in turn is perhaps not specifically distinct from the Malayan *P. pisocarpa* Endl. The present species is strongly characterized by its narrow, lanceolate, slenderly acuminate leaves.

## MYRISTICACEAE

### HORSFIELDIA Willdenow

**HORSFIELDIA ACUMINATA** sp. nov. § *Irya, Euirya.*

Arbor, ramulis junioribus inflorescentiisque exceptis glabra, ramulis teretibus, haud longitudinaliter lineatis; foliis chartaceis, lanceolatis ad oblongo-lanceolatis, 15 ad 20 cm longis, basi acutis, apice tenuiter acuminatis, nervis utrinque circiter 16, tenuibus, distinctis; inflorescentiis ♂ axillaribus, paniculatis, usque ad 12 cm longis, ferrugineo-pubescens, floribus breviter pedicellatis, confertis, circiter 1.5 mm diametro.

A tree, glabrous except the very youngest branchlets and the inflorescences which are more or less ferruginous-pubescent. Branches terete, reddish-brown, lenticellate, the twigs without longitudinal lines. Leaves chartaceous, lanceolate to oblong-lanceolate, 15 to 20 cm long, 3.5 to 4 cm wide, somewhat olivaceous, shining, the base acute, the apex slenderly acuminate; lateral nerves about 16 on each side of the midrib, slender, distinct; petioles about 8 mm long. Staminate inflorescences axillary, paniculate, up to 12 cm long, branched from near the base, the primary branches up to 4.5 cm in length, the flowers somewhat crowded on the ultimate branchlets, the rachis, branches, and branchlets when young densely ferruginous-pubescent, the indumentum somewhat deciduous. Staminate flowers globose, glabrous, about 1.5 mm in diameter, the perianth 2-valved, their pedicels up to 1 mm long. Anther cells short, on the margin of the disk, their tips free.

MINDANAO, Davao Province, Astorga, *For. Bur. 27507 De Mesa,* April 23, 1919, in rich, level, forested areas, altitude about 20 meters, with the local Maguindanao name *kaná.*

A species belonging in the group with *Horsfieldia irya* Warb.

but distinguished from it and its congeners by a number of characters.

**HORSFIELDIA RAMOSII** sp. nov.

Arbor parva, ramulis et inflorescentiis et foliis subtus secus costam castaneo-stellato-pubescens, ramulis ultimis haud lineatis; foliis oblongis ad oblongo-lanceolatis, subcoriaceis, 13 ad 17 cm longis, basi acutis, apice tenuiter acute acuminatis, nervis utrinque circiter 15, reticulis laxis, subobsoletis; inflorescentiis ♀ axillaribus, 2 ad 3 cm longis, paucifloris, racemosis vel depauperato-paniculatis; floribus globosis, 2 mm diametro.

A tree, the branchlets and lower surface of the leaves along the midrib stellate-pubescent with short, castaneous hairs, the indumentum somewhat deciduous, the branches glabrous, the ultimate branchlets without longitudinal lines. Leaves oblong to oblong-lanceolate, subcoriaceous, 13 to 17 cm long, 4 to 6 cm wide, narrowed below to the acute or somewhat decurrent base, and above to the slenderly and sharply acuminate apex; lateral nerves about 15 on each side of the midrib, obscurely anastomosing, the reticulations lax, indistinct or obsolete; petioles 8 to 12 mm long, stellate-pubescent when young, becoming glabrous. Pistillate inflorescences axillary and from the axils of fallen leaves, stellate-pubescent, 2 to 3 cm long, few-flowered, racemose or depauperate-paniculate, the primary branches when present few, about 3 mm long. Perianth glabrous, globose or ovoid, 2-valved, about 2 mm in diameter, the pedicels about 2 mm long.

BUCAS GRANDE, *Bur. Sci. 35047 Ramos & Pascasio,* June 11, 1919, in dry forests at low altitudes.

This species is apparently most closely allied to *Horsfieldia obscurinervia* Merr., but is readily distinguished by its castaneous, stellate indumentum on the branchlets, inflorescences, and lower surface of the leaves. The two species are not, however, directly comparable, as of the latter the staminate flowers are known and of the species described above only the pistillate ones.

## MYRISTICA Linnaeus

**MYRISTICA LAXIFLORA** sp. nov.

Arbor, subtus foliis et ramulis et inflorescentiis ferrugineo-pubescens; foliis lanceolatis ad oblongo-lanceolatis, chartaceis, 10 ad 15 cm longis, utrinque angustatis, basi acutis, apice acutis vel leviter acuminatis, supra glabris, nitidis, subtus subcupreis, nervis utrinque circiter 12, tenuibus, reticulis subobsoletis; inflorescentiis ♂ axillaribus, paniculatis, laxis, 4.5 ad 6 cm longis; floribus subumbellatim dispositis, pedicellatis, ellipsoideis, 4 mm longis; fructibus ellipsoideis, circiter 4.5 cm longis, dense ferrugineo-puberulis.

A tree, the branchlets, inflorescences, and leaves on the lower surface ferruginous-pubescent or puberulent with dense short hairs. Branches reddish-brown, glabrous. Leaves lanceolate to oblong-lanceolate, chartaceous, 10 to 15 cm long, 2.5 to 4.5 cm wide, narrowed below to the acute base and above to the acute or somewhat acuminate apex, the upper surface glabrous, smooth and shining when dry, the lower often somewhat cupreous from the rather dense, close indumentum; lateral nerves about 12 on each side of the midrib, slender and not prominent, scarcely impressed on the upper surface, the reticulations nearly obsolete; petioles 1 to 2.5 cm long, when young pubescent, eventually glabrous. Staminate inflorescences axillary, paniculate, rather lax, 4.5 to 6 cm long, ferruginous-pubescent, the primary branches 1.5 cm long or less, the flowers rather laxly and umbellately arranged at the tips of the branches, their pedicels 4 to 5 mm long. Perianth about 4 mm long, pubescent, ellipsoid, 3-lobed, anthers about 8, the anther-mass about 1.5 mm long, borne on a 1-mm long column; bracteole at the base of the calyx reniform, obscure, 0.4 mm long or less. Fruit ellipsoid, ferruginous and rather densely puberulent, when dry smooth, about 4.5 cm long, and the aril laciniate to the very base.

BASILAN, *Bur. Sci. 15498 Reillo* (type), August 14, 1912, in forests at low altitudes. TINAGO, *Ahern 421*, February to June, 1901, with the local name *dugan.*

A species belonging in the *littoralis* series, well characterized by its cupreous or ferruginous indumentum and by its rather large, lax, minutely bracteolate, staminate inflorescences. *Ahern 421* cited above is a fruiting specimen and was originally identified as *Myristica cumingii* Warb.

**MYRISTICA CAGAYANENSIS** sp. nov.

Arbor circiter 8 m alta, ramulis junioribus fructibusque ferrugineo-pubescens; foliis coriaceis, oblongis, 13 ad 18 cm longis, utrinque obtusis vel apice late obtuseque acuminatis, nervis utrinque circiter 18, reticulis subobsoletis; fructibus ellipsoideis, circiter 7 cm longis, minute ferrugineo-pubescens, in siccitate rugosis, seminibus circiter 4 cm longis.

A tree, about 8 m high, the very tips of the branchlets and the fruits ferruginous-pubescent, otherwise glabrous (inflorescences unknown). Leaves coriaceous, oblong, 13 to 18 cm long, 4 to 5.5 cm wide, the base obtuse to rounded, the apex obtuse or very broadly obtuse-acuminate, the lower surface distinctly paler than the upper, sometimes slightly glaucous; lateral nerves about 18 on each side of the midrib, somewhat impressed on the upper surface, slightly projecting on the lower surface, the reticulations nearly obsolete; petioles 1.5 to 2 cm long. Fruits solitary, ellipsoid or cylindric, brown and minutely ferruginous-pubescent when mature, rugose, about 7 cm long, the seed smooth, shining, about 4 cm long, the aril laciniate nearly to the base.

LUZON, Cagayan Province, San Vicente, *For. Bur. 24277 Bernardo,* August 12, 1915, in dense forests at low altitudes with the local Negrito name *n̄gabn̄gab.*

A species apparently belonging with *Myristica philippensis* Lam. but with much smaller, entirely glabrous leaves.

## KNEMA Loureiro

**KNEMA ACUMINATA** sp. nov.

Arbor circiter 12 m alta, ramulis fructibusque ferrugineo-pubescens; foliis subcoriaceis, lanceolatis ad oblongo-lanceolatis, 3 ad 13 cm longis, basi acutis, sursum angustatis, tenuiter acuminatis, supra subolivaceis, nitidis, subtus pallidioribus, vix glaucescentibus, nervis utrinque 8 ad 12, perspicuis; fructibus subglobosis ad ovoideis, 1.5 ad 2 cm longis.

A tree, about 12 m high, the branchlets and fruits ferruginous-pubescent. Leaves subcoriaceous, lanceolate to oblong-lanceolate, entire, 9 to 13 cm long, 2.5 to 4.5 cm wide, the base acute or somewhat decurrent-acuminate, the apex slenderly acuminate, the upper surface somewhat olivaceous, glabrous, the lower pale but scarcely glaucous, glabrous or nearly so; lateral nerves distinct, 8 to 12 on each side of the midrib, the reticulations fine, rather close; petioles 1 to 1.5 cm long. Fruits subglobose to ovoid, 1.5 to 2 cm long, ferruginous-pubescent, their pedicels about 7 mm long, usually 3 borne on a common, very short, axillary peduncle at most 5 mm in length.

LUZON, Isabela Province, Ilagan, *For. Bur. 11266 Klemme,* May 18, 1908, in dense level forests at low altitudes.

A species probably most closely allied to *Knema vidalii* Warb., but easily distinguished by its slenderly acuminate, few-nerved leaves.

## LAURACEAE

### CRYPTOCARYA R. Brown

**CRYPTOCARYA OLIGOCARPA** sp. nov.

Frutex vel arbor parva, partibus junioribus exceptis glabra; foliis coriaceis, oblongo-ellipticis ad oblongo-ovatis, 6 ad 10 cm longis, apice breviter obtuseque acuminatis, basi acutis vel rotundatis, utrinque laevis, supra nitidis, subtus albido-glaucescentibus, nervis utrinque circiter 7, perspicuis; infructescentiis axillaribus, spicatus, usque ad 1.5 cm longis, fructibus paucis ellipsoideis, nitidis, glabris, circiter 1 cm longis.

A shrub or small tree, glabrous except the younger parts. Branches terete, glabrous, usually brownish, the very young branchlets appressed-pubescent, soon becoming glabrous. Leaves coriaceous, oblong-elliptic to oblong-ovate, 6 to 10 cm long, 2.5 to 5 cm wide, the apex shortly and obtusely acuminate, the base acute to rounded, the upper surface smooth, shining, pale greenish when dry, the lower surface glaucous; lateral nerves about 7 on each side of the midrib, prominent on the lower surface, brown in contrast with the glaucous epidermis, the reticulations slender, not prominent; petioles 8 to 10 mm long, glabrous. Infructescences in the uppermost axils, usually reduced to a simple spike, the axils 1.5 cm long or less. Fruits few, somewhat ellipsoid, smooth, shining, glabrous, nearly black when dry, about 1 cm long.

MINDANAO, Surigao Province, *Bur. Sci. 34716 Ramos & Pascasio*, June 14, 1919, at the iron deposit on the northeast coast along streams at low altitudes.

This species is apparently most closely allied to *Cryptocarya ramosii* Merr., but the leaves and fruits are smaller and the former are not at all foveolate, both surfaces being entirely smooth.

## PITTOSPORACEAE

### PITTOSPORUM Banks

**PITTOSPORUM OBSCURINERVE** sp. nov.

Arbor parva, ramulis junioribus leviter ferrugineo-pubescens; foliis verticillatis, coriaceis, rigidis, oblongis-obovatis ad oblanceolatis, 7 ad 9 cm longis, acutis vel breviter acuminatis, basi tenuiter cuneatis; nervis utrinque circiter 7, tenuibus, obscuris; capsulis subumbellatis, oblongis 2-valvis, circiter 1.8 cm longis.

A glabrous tree, about 4 m high, the very young branchlets more or less ferruginous-pubescent. Leaves verticillate, coriaceous, rigid, brownish-olivaceous and slightly shining when dry, oblong-obovate to oblanceolate, 7 to 9 cm long, 1.5 to 3.5 cm wide, the apex acute or shortly and acutely acuminate, narrowed below to the slenderly cuneate base; lateral nerves about 7 on each side of the midrib, very slender, obscure, obsolete on the upper surface; petioles about 1 cm long. Infructescences terminal, subumbellate, their peduncles up to 4 cm long slightly pubescent, the pedicels 1 cm long or less. Capsules yellow when fresh, fleshy, glabrous, oblong, about 1.8 cm long, 2-valved, the valves black and rugose when dry, spreading, obtuse.

MINDANAO, Surigao Province, *Bur. Sci. 34441 Ramos & Pascasio,* April 25, 1919, along small streams at the iron deposit on the northeast coast, altitude about 590 meters.

A species belonging in the group with *Pittosporum odoratum* Merr., but readily distinguishable by its thickly coriaceous, rigid, very obscurely nerved leaves.

**PITTOSPORUM EUPHLEBIUM** sp. nov.

Frutex vel arbor parva, ramulis junioribus leviter ferrugineo-pilosis; foliis verticillatis, chartaceis, oblongis ad oblongo-oblanceolatis, nitidis, acute acuminatis, basi cuneatis, nervis utrinque circiter 5, subtus cum reticulis valde perspicuis; capsulis terminalibus, solitariis anguste ellipsoideis, 2-valvis, circiter 3 cm longis.

A shrub or small tree, glabrous except the very young parts which are sparingly ferruginous-pilose, the indumentum deciduous, branchlets slender, terete, the internodes 7 to 14 cm long. Leaves verticillate, chartaceous, oblong to oblong-oblanceolate, olivaceous, shining, the apex sharply acuminate, the base cuneate, 7 to 12 cm long, 2 to 3 cm wide; lateral nerves about 5 on each side of the midrib, distant, very prominent on the lower surface, projecting, laxly anastomosing, the primary reticulations lax, distinct. Capsules terminal, solitary, narrowly ellipsoid and nearly smooth when dry, 2-valved, about 3 cm long, their peduncles about 1.5 cm in length.

PANAY, Capiz Province, Libacao, *Bur. Sci. 35416 Martelino & Edaño,* May 30, 1919, on open forested slopes at low altitudes.

By its solitary, terminal capsules this species apparently belongs in the group with *Pittosporum glaberrimum* Merr. from which it is distinguished by its larger leaves and capsules and by its nerves and lax reticulations being prominently raised on the lower surface.

## ROSACEAE

### ROSA Linnaeus

**ROSA LUZONIENSIS** sp. nov. § *Synstylae.*

Frutex scandens, usque ad 4 m altus, glaber, ramis aculeatis, aculeis sparsis, curvatis, tenuibus, usque ad 6 mm longis; foliis 3 ad 5 cm longis, 5- vel 7-foliatis, foliolis parvis, elliptico-ovatis, leviter acuminatis, 5 ad 15 mm longis, inermis vel subtus ad costa aculeis paucis armatis; stipulis adnatis, margine pectinatis atque glandulis capitatis paucis instructis; floribus plerumque solitariis, calycis tubo glabro, lobis oblongo-lanceolatis, usque ad 10 mm longis, intus pilosis, extus glabris, margine parce capitato-gandulosis, atque laciniis tenuibus 2 vel 3 utrinque instructis; stylis circiter 15, glabris, connatis, 3 ad 5 mm longis.

A scandent shrub, attaining a length of 4 m, glabrous except the inner surface of the sepals. Branches armed with slender, somewhat curved spines 4 to 6 mm in length. Leaves pinnate, 5- or 7-foliolate, 3 to 5 cm long, glabrous, the leaflets small, elliptic-ovate, acute or acuminate, or the lower ones sometimes obtuse, sharply serrate, 5 to 15 mm long, the midrib beneath unarmed or with a few short spines; stipules adnate, pectinate, the outer margins also somewhat capitate-glandular. Flowers white, mostly solitary, about 3 cm in diameter, their pedicels unarmed, not at all glandular, usually about 1 cm long. Calyx-tube glabrous, oblong-obovoid, about 6 mm long; lobes oblong-lanceolate, about 10 mm long, externally glabrous, inside pubescent, the margins sparingly capitate-glandular and with two or three, slender, 1.5 to 2 mm long laciniae on each side. Petals broadly obovate, about 17 mm long, retuse. Stamens indefinite, their filaments glabrous, up to 5 mm long. Styles about 15, glabrous, more or less united, 3 to 5 mm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31876 Santos* (type), May 29, 1918, *Bur. Sci. 4300 Mearns,* July, 1907, *Bur. Sci. 8336 McGregor,* June, 1909, on slopes in thickets near the mossy forest, altitude about 2,300 meters, with the local name *pauican.*

This form has been confused with *Rosa multiflora* Thunb., from which, among other characters, it is distinguished by its much smaller leaves and leaflets; in being entirely glabrous, except for the sepals; in the absence of capitate glands on the branchlets and vegetative parts; and in its usually solitary flowers. It is apparently closely allied to the Formosan *Rubus transmorrisonensis* Hayata.

**ROSA PHILIPPINENSIS** sp. nov. § *Synstylae.*

*Rosa multiflora* Vidal Rev. Pl. Vasc. Filip. (1886) 123; Merr. in Philip. Journ. Sci. 5 (1910) Bot. 352, non Thunb.

Frutex suberectus vel scandens, 1 ad 4 m altus, ramis parce aculeatis, ramulis perspicue capitato-glandulosis; foliis 5- ad 9-foliolatis, 9 ad 12 cm longis, glabris, foliolis chartaceis, oblongo-ellipticis ad oblongo-ovatis, 3 ad 5 cm longis, serratis, plerumque acutis; stipulis adnatis, angustis, haud pectinatis, margine capitato-glandulosis; floribus numerosis, paniculatis, 3 ad 3.5 cm diametro, pedicellis calycibusque extus leviter hirsutis atque capitato-glandulosis, lobis oblongo-lanceolatis, caudato-acuminatis, usque ad 12 mm longis, intus cinereo-villosis, margine plerumque integris vel lobis angustis 1 vel 2 utrinque instructis; stylis connatis, hirsutis, circiter 5 mm longis.

A suberect or more or less scandent shrub, 1 to 4 m in height, nearly glabrous. Branches armed with scattered, stout, recurved spines about 4 mm in length, the branchlets conspicuously capitate-glandular as are the inflorescences and calyces. Leaves 5- to 9-foliolate, glabrous, 9 to 12 cm long, the rachis sparingly aculeate; leaflets chartaceous, oblong-elliptic to oblong-ovate, mostly acute, 3 to 5 cm long, sharply serrate; stipules adnate, scarcely pectinate, narrow, their margins capitate-glandular, the linear, free, apical parts 3 mm long or less. Panicles terminal, ample, somewhat leafy, many-flowered, up to 20 cm in length, all parts capitate-glandular, the pedicels 2.5 to 4 cm long. Flowers white, 3 to 3.5 cm in diameter. Calyx-tube somewhat pubescent, glandular-capitate, about 5 mm long, the lobes oblong-lanceolate, caudate-acuminate, up to 12 mm long, pubescent and capitate-glandular outside, inside densely cinereous-pubescent, caudate-acuminate, entire or with one or two narrow lobes on each side. Petals obovate, retuse. Stamens indefinite. Styles hirsute, connate, about 5 mm long.

LUZON, Benguet Subprovince, Baguio and vicinity, *Elmer 5794* (type), *Merrill Phil. Pl. 882, Bur. Sci. 2519, 4290 Mearns, Sandkuhl 371, Santos 14:* Bontoc Subprovince, *Vanoverbergh 50.* In thickets, gulches, etc., in the pine region, altitude 1,200 to 1,700 meters.

This species has long been confused with *Rosa multiflora* Thunb., the typical form of which is apparently confined to Japan and Korea. A more critical examination of the Philippine material than has hitherto been made shows that this form is distinguishable from Thunberg's species in numerous characters and is really more closely allied to *Rosa wichuraiana* Crépin than to *R. multiflora* Thunb.

Var. **DEPAUPERATA** var. nov.

A typo differt foliis minoribus, foliolis 1 ad 3 cm longis.

LUZON, Benguet Subprovince, *Williams 972, Clemens 9106, Elmer 8416, Merrill 4643, 6532, Topping 32, Bur. Sci. 3376 Mearns, Bur. Sci. 5568, 5821 Ramos, For. Bur. 18168 Curran, Zschokke, & Merritt:* Bontoc Subprovince, *For. Bur. 14462 Darling:* Lepanto Subprovince, *For. Bur. 5746 Klemme:* Ifugao Subprovince, *Bur. Sci. 19653 McGregor.*

In the same habitats as the typical form of the species but more abundant. The recorded local names are *pigit* in Bontoc and *kuyaob* in Lepanto.

## CONNARACEAE

### CONNARUS Linnaeus

**CONNARUS CAUDATUS** sp. nov.

Frutex scandens, inflorescentiis exceptis glaber, foliis usque ad 30 cm longis, 5-foliolatis, foliolis oblongo-ovatis ad oblongo-lanceolatis, nitidis, subcoriaceis, usque ad 17 cm longis, apice tenuiter caudato-acuminatis, basi obtusis et minutissime, peltatis, nervis utrinque plerumque 4, distinctis; infructescentiis leviter castaneo-pubescens, paniculatis, folliculis oblique obovoideis, extus glabris, intus pubescens, circiter 2.5 cm longis, apice rotundatis, oblique rugulosis vel striatis.

A woody vine, glabrous except the inflorescences. Leaves up to 30 cm long, pinnately 5-foliolate; leaflets oblong-ovate to oblong-lanceolate, olivaceous, shining, subcoriaceous, 7 to 17 cm long, 2.5 to 5 cm wide, the apex long and slenderly caudate-acuminate, the base obtuse and very minutely peltate; lateral nerves usually 4 on each side of the midrib, distinct, anastomosing, the reticulations lax. Infructescences peduncled, somewhat castaneous-pubescent, paniculate, the follicles obliquely obovoid, slightly compressed, about 2.5 cm long, the apex broadly rounded, the base acute, the remains of the style somewhat lateral, the valves brown when dry, rugulose or striate, glabrous externally or very slightly pubescent when young, inside more or less pubescent.

BUCAS GRANDE, *Bur. Sci. 35059 Ramos & Pascasio,* June 10, 1919, in dry forests at low altitudes.

In its follicle characters this species is similar to *Connarus* *neurocalyx* Planch., but it differs radically from Planchon's species in its caudate-acuminate leaflets.

### ELLIPANTHUS Hooker f.

**ELLIPANTHUS LONGIFOLIUS** sp. nov.

Arbor parva, ramulis et inflorescentiis et fructibus exceptis glaber; foliis anguste oblongo-lanceolatis, coriaceis, 23 ad 30 cm longis, 4 ad 6 cm latis, apice tenuiter acuminatis, basi late acutis, utrinque nec profunde foveolatis, nervis utrinque circiter 9, distantibus, distinctis; fructibus inaequilateralibus, oblongis, circiter 3 cm longis, acuminatis, deorsum angustatis, extus densissime castaneo-pubescens.

A shrub or small tree, glabrous except the very young branchlets, inflorescences, and fruits. Branches terete, glabrous, reddish-brown. Leaves narrowly oblong-lanceolate, coriaceous, 23 to 30 cm long, 4 to 6 cm wide, shining when dry, the apex slenderly acuminate, the base broadly acute; lateral nerves about 9 on each side of the midrib, distant, distinct, anastomosing, the ultimate reticulations often distinct; both surfaces appearing shallowly foveolate; petioles 1.5 to 3 cm long. Infructescences axillary and from the axils of fallen leaves, the carpels either solitary or in pairs or threes on a common peduncle which is less than 1 cm in length. Follicles inequilateral, oblong, about 3 cm long and 1 cm wide, one side nearly straight, the other curved, apex acuminate, base narrowed into a 5 mm long pseudostalk, densely pubescent outside with short castaneous hairs.

DINAGAT, *Bur. Sci. 35180 Ramos & Pascasio,* May 12, 1919, on the forested banks of small streams at low altitudes.

A species belonging in the group with *Ellipanthus luzoniensis* Vid., but readily distinguished by its elongated narrow leaves.

## LEGUMINOSAE

### PITHECOLOBIUM Martius

**PITHECOLOBIUM SESSILIFLORUM** sp. nov.

Arbor parva, inflorescentiis perspicue ferrugineo-pubescens, ramulis angulatis; foliis circiter 40 cm longis, pinnae plerumque 10-jugis, jugis intermediis usque ad 17 cm longis, apice 1-glandulosis; foliis circiter 15-jugis, rhomboideis vel oblique rhomboideis, valde inaequilateralibus, subcoriaceis, 1.5 ad 3.5 cm longis, acuminatis; paniculis usque ad 50 cm longis, floribus sessilibus, subumbellatim confertis, calycis dense ferrugineo-pubescens, corolla 8 ad 9 mm longa, dense ferrugineo-pubescens.

A small tree, about 4 m high, the inflorescences prominently ferruginous-pubescent on the younger parts, the plant otherwise nearly glabrous, the branchlets dark brown when dry, prominently angled. Leaves about 40 cm long, the pinnae usually about 10 pairs, the lowest 1 or 2 pairs usually much shorter than the others, the intermediate ones up to 17 cm long, the main rachis slightly pubescent as are the secondary ones, angular, and with a single prominent gland near the base, the secondary rachises with a single small gland at the base of the ultimate pair of leaflets; leaflets on the intermediate pinnae about 15 pairs, rhomboid or obliquely rhomboid, very inequilateral, the midrib diagonal, subcoriaceous, brown and strongly shining when dry, 1.5 to 3.5 cm long, 6 to 15 mm wide, acuminate, the lower surface very sparingly pubescent. Panicles terminal, ample, peduncled, up to 50 cm long, the flowers white, numerous, subumbellately crowded at the tips of the ultimate branchlets, sessile or nearly so, the subtending bracteoles obovate to oblong-obovate, somewhat acuminate, about 3 m long. Calyx about 4 mm long, densely ferruginous-pubescent, cup-shaped, the teeth triangular, acute, about 1 mm long. Corolla 8 to 9 mm long, densely ferruginous-pubescent, the lobes oblong-ovate, about 3.5 mm long. Ovary oblong-ovate to somewhat obovate, pubescent, 1.5 to 2 mm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34675 Ramos & Pascasio,* June 15, 1919, along streams at low altitudes at the iron deposit on the northeast coast.

A species belonging in the group with *Pithecolobium clypearia* Benth. and in this group apparently most closely allied to *Pithecolobium contortum* Mart., from which it is readily distinguished, among other characters, by its very densely ferruginous-pubescent corollas.

### ORMOSIA Jackson

**ORMOSIA SURIGAENSIS** sp. nov.

Arbor, ramulis junioribus inflorescentiisque dense ferrugineo-pubescens; foliis 11 ad 15 cm longis, foliolis 5 vel 7, coriaceis, oblongo-ovatis ad oblongo-ellipticis, olivaceis, nitidis, 5 ad 9 cm longis, basi late rotundatis, apice obtusis vel late obtuseque acuminatis; paniculis terminalibus, circiter 20 cm longis, e basi ramosis; calycis dense ferrugineo-pubescens, lobis oblongis, obtusis, circiter 6 mm longis, vexilla violacea, late reniformi-orbicularis, appendicibus anterioribus carnosis, oblongis, 2.5 mm longis; ovulis plerumque 3.

A tree, the very young branchlets and inflorescences densely ferruginous-pubescent, otherwise glabrous or nearly so. Leaves 11 to 15 cm long, the rachis and petioles sparingly pubescent, ultimately glabrous or nearly so; leaflets 5 or 7, coriaceous, oblong-ovate to oblong-elliptic, olivaceous, shining, 5 to 9 cm long, 2.5 to 5 cm wide, the base usually broadly rounded, apex obtuse or broadly and obtusely acuminate; lateral nerves usually 6 on each side of the midrib, slender, not prominent; petiolules 5 to 7 mm long. Panicles terminal, branched from the base, about 20 cm long, the lower branches up to 13 cm in length. Flowers numerous, their pedicels about 1 cm long. Calyx densely ferruginous-pubescent, about 1.5 cm in diameter, the lobes oblong-ovate, about 6 mm long, 4.5 mm wide, obtuse. Petals violet, glabrous, the standard reniform-orbicular, rounded, about 13 mm wide, the claw stout, thick, with two anterior oblong, fleshy, 2.5 mm long appendages, wing and keel of the petals subequal, their claws 4 to 6 mm long. Filaments glabrous. Ovary oblong, densely pubescent, usually 3-ovulate.

MINDANAO, Surigao Province, *Bur. Sci. 34494 Ramos & Pascasio,* April 24, 1919, on ridges at low altitudes at the iron deposit on the northeast coast.

The alliance of this species is not entirely clear, as the fruits are unknown. It is, however, radically different from all other species of the genus known to me.

## LINACEAE

### IXONANTHES Jack

**IXONANTHES LONGIPEDUNCULATA** sp. nov.

Arbor parva, glabra; foliis ellipticis ad elliptico-obovatis, 9 ad 12 cm longis, apice rotundatis, basi acutis, coriaceis, nitidis, nervis utrinque circiter 8; infructescentiis axillaribus, longe pedunculatis, apice dichotome ramosis, ramis primariis circiter 1 cm longis, pedunculis circiter 15 cm longis; capsulis oblongis, 2.5 cm longis, sepalis persistentibus rotundato-ovatis, 5 ad 7 mm longis.

A glabrous tree, 4 to 5 m high, the branchlets smooth, reddish-brown. Leaves elliptic to elliptic-obovate, rounded, the base usually acute and often narrowly decurrent along the petioles, brownish-olivaceous when dry, shining, 9 to 12 cm long, 5 to 8 cm wide; lateral nerves about 8 on each side of the midrib, distinct, as are the reticulations. Petioles about 2 cm long. Infructescences axillary, solitary, 2-branched at the apex, the primary branches 1 cm long, the peduncles about 15 cm long. Capsules oblong, 2.5 cm long, the persistent sepals ovate-rounded, 5 to 7 mm long.

MINDANAO, Surigao Province, *Bur. Sci. 34488 Ramos & Pascasio,* April 24, 1919, at the iron deposit on the northeast coast, on ridges at low altitudes.

This is the second representative of this small genus to be found in the Philippines and is strongly characterized by its elongated peduncles.

## RUTACEAE

### EVODIA Forster

**EVODIA CORIACEA** sp. nov.

Arbor parva, partibus junioribus exceptis glabra, ramulis circiter 6 mm diametro; foliis 3-foliolatis, foliolis coriaceis, obovatis ad oblongo-obovatis, 6 ad 8 cm longis, apice late rotundatis admodum leviter retusis, basi cuneatis, nervis utrinque circiter 7, cum reticulis valde perspicuis; infructescentiis axillaribus, 2 ad 2.5 cm longis, depauperato-paniculatis, fructibus confertis, coccis ovoideis, 4 mm longis.

A small tree, glabrous except the younger parts, ultimate branches about 6 mm in diameter, rugose, the petiolar scars large and conspicuous. Leaves 3-foliate, their petioles 3.5 to 7 cm long; leaflets coriaceous, somewhat shining, obovate to oblong-obovate, 6 to 8 cm long, 3.5 to 4.5 cm wide, the apex broadly rounded, sometimes slightly retuse, narrowed below to the cuneate or somewhat decurrent-acuminate base; lateral nerves about 7 on each side of the midrib, prominent and conspicuous as are the lax reticulations; petiolules 5 to 8 mm long. Infructescences axillary, 2 to 2.5 cm long, depauperate-paniculate, the fruits somewhat crowded, the individual cocci ovoid, about 4 mm in length.

DINAGAT, *Bur. Sci. 35172 Ramos & Pascasio,* May 12, 1919, in forests at low altitudes.

In many respects this species resembles *Evodia laxireta* Merr., from which it is readily distinguished by its shorter infructescences and smaller fruits, as well as by its shorter, differently shaped, rounded or retuse, fewer-nerved leaflets.

### TETRACTOMIA Hooker f.

**TETRACTOMIA ACUMINATA** sp. nov.

Frutex 3 ad 5 m altus, inflorescentiis leviter pubescens exceptis glaber; foliis oblongo-obovatis ad oblongo-ellipticis, subcoriaceis, basi acutis, apice perspicue sed breviter acuminatis, nervis utrinque 8 ad 10, distinctis; inflorescentiis axillaribus, solitariis, pedunculatis, 7 ad 13 cm longis, partibus junioribus leviter pubescens, floribus numerosis; calycis lobis late ovatis; petalis accrescentibus, persistentibus, ad 4 mm longis; capsulis solitariis, oblongis, obtusis, rugosis, 5 mm longis.

A shrub, 3 to 5 m high, glabrous except the younger parts of the inflorescences, the branches usually reddish-brown. Leaves oblong-obovate to oblong-elliptic, 8 to 13 cm long, 4 to 6 cm wide, subcoriaceous, narrowed to the acute base and to the conspicuously but shortly acuminate apex, brownish or olivaceous when dry, shining; lateral nerves 8 to 10 on each side of the midrib, distinct, anastomosing; petioles 1.5 to 2.5 cm long, jointed with the leaflets. Inflorescences axillary, solitary, peduncled, 7 to 13 cm long, the branches spreading or ascending, the younger parts sparingly pubescent. Flowers numerous, yellowish-green, 4-merous. Calyx about 4 mm in diameter, the lobes 4, broad. Petals ovate, acute, persistent and accrescent, up to 4 mm long. Filaments of the 4 fertile stamens 2.5 mm long, on the margin of the very broad disk, carpels 4 but only 1 developing into a fruit. The mature capsule oblong, obtuse, 5 mm long, the valves rugose externally. Seed solitary, including the broad 2.5 mm wide wing about 4 mm in length.

BUCAS GRANDE, *Bur. Sci. 35135* (type), *35106 Ramos & Pascasio,* June 10, 1919. MINDANAO, Surigao Province, at the iron deposit on the northeast coast, *Bur. Sci. 34707 Ramos & Pascasio,* June 15, 1919, in forests at low altitudes, ascending to 350 meters.

The third species of this genus to be found in the Philippines and readily distinguishable from its congeners by its acuminate leaves.

## SIMARUBACEAE

### EURYCOMA Jack

**EURYCOMA EGLANDULOSA** sp. nov.

Arbor parva, inflorescentiis et ramulis junioribus exceptis glabra; ramulis incrassatis, 1.5 ad 2 cm diametro; foliis numerosis, confertis, usque ad 60 cm longis, foliolis circiter 30, coriaceis, anguste oblongis ad anguste oblongo-obovatis, acutis ad rotundatis, basi acutis, 6 ad 8 cm longis; paniculis axillaribus, foliis aequantibus, castaneo-pubescens, haud glandulosis; floribus circiter 7 mm longis, petalis utrinque pubescens.

A small tree, 7 to 8 m high, glabrous except the tips of the branchlets and the inflorescences, the ultimate branchlets terete, 1.5 to 2 cm in diameter. Leaves numerous, crowded at the tips of the branchlets, about 60 cm long, the rachis reddish-brown when dry, glabrous; leaflets about 15 pairs, coriaceous, narrowly oblong to narrowly oblong-obovate, the upper surface brownish-olivaceous and strongly shining when dry, the lower surface much paler and scarcely shining, 6 to 8 cm long, 1.5 to 2 cm wide, base acute, often slightly inequilateral, apex rounded to acute; lateral nerves indistinct, 12 to 15 on each side of the midrib; petiolules 2 mm long or less. Panicles axillary, as long as the leaves, sparingly castaneous-pubescent with very short simple hairs, not at all glandular. Flowers about 7 mm long. Calyx-teeth ovate, obtuse, about 1.5 mm long, puberulent. Petals oblong, acute or obtuse, about 6 mm long and 3 mm wide, both surfaces puberulent, the margins below inflexed. Filaments 2.5 mm long, the basal glandular appendages 2, narrowly oblong, up to 1 mm long, slightly pubescent. Ovary pubescent. Immature fruits oblong-ellipsoid, 1.5 mm long, apex rounded, base narrowed and subacute.

MINDANAO, Surigao Province, *Bur. Sci. 34592 Ramos & Pascasio* (type), April 24, 1919. DINAGAT, *Bur. Sci. 35207 Ramos & Pascasio,* May 12, 1919. On ridges and in forests at low altitudes, the type from the iron deposit on the northeast coast of Surigao.

*Eurycoma longifolia* Jack has been accredited to Luzon on the basis of a specimen, so labeled, collected by Lobb; it is absolutely certain that Lobb's specimen came from Malay Peninsula or from Borneo where Jack's species is common, and not from Luzon. The present species then is the first definite record for this small genus for the Philippines. In general appearance *Eurycoma eglandulosa* closely resembles *E. longifolia,* but the indumentum on the inflorescences consists solely of very short, castaneous, simple hairs, and is never glandular as in Jack's species.

## BURSERACEAE

### CANARIUM Linnaeus

**CANARIUM UNIFOLIOLATUM** sp. nov.

Arbor parva, glaberrima, foliis 1-foliolatis, oblongis, coriaceis, nitidis, integris, 9 ad 15 cm longis, perspicue acuminatis, basi acutis, nervis utrinque 8 ad 10, perspicuis; racemis axillaribus, 1.5 ad 2 cm longis, paucifloris, floribus circiter 4 mm longis; drupis subteretibus, leviter inaequilateralibus, acutis, circiter 1.3 cm longis, rugosis.

A small, entirely glabrous tree with simple leaves. Leaves oblong, coriaceous, shining when dry, 9 to 15 cm long, 3.5 to 6 cm wide, entire, the apex rather prominently acuminate, the base acute; lateral nerves 8 to 10 on each side of the midrib, prominent, the reticulations distinct. Petioles 5 to 20 cm long. Racemes simple, axillary, few-flowered, 1.5 to 2 cm long, the pedicels stout, 1.5 mm long or less, the bracteoles linear-lanceolate, acuminate, about 1 mm long. Calyx somewhat cup-shaped, narrowed below, 2 to 2.5 mm long, the lobes short, broader than long. Petals oblong-elliptic, 3 mm long. Disk prominent, truncate. Staminodes 6, inserted outside of the disk. Ovary ovoid, 1.2 mm long. Fruit nearly terete, oblong-ovoid, somewhat inequilateral, acute, about 1.3 cm long, the pericarp thin, wrinkled when dry.

MINDANAO, Surigao Province, *Bur. Sci. 34720 Ramos & Pascasio,* June 14, 1919, along streams at low altitudes at the iron deposit on the northeast coast.

A species belonging in the same group with *Canarium villosum* F.-Vill. but distinguished from all previously described forms of the genus by its simple leaves.

## MELIACEAE

### DYSOXYLUM Blume

**DYSOXYLUM CAPIZENSE** sp. nov. § *Eudysoxylum.*

Arbor parva, partibus junioribus inflorescentiisque puberulis; foliis alternis, usque ad 18 cm longis, foliolis oppositis, circiter 10, chartaceis, nitidis, oblongo-ovatis ad oblongo-lanceolatis, 4 ad 8 cm longis, acuminatis, nervis utrinque circiter 15, indistinctis, reticulis subobsoletis; inflorescentiis solitariis, spiciformibus, e axillis defoliatis, 4 ad 5 cm longis; floribus 4-meris, 5 ad 6 cm longis, calycis circiter 3 mm diametro; petalis oblongis, extus puberulis; ovario 4-locellato, pubescente.

A tree, about 5 m high, the young branchlets, inflorescences, and petioles grayish or yellowish puberulent. Leaves alternate, 15 to 18 cm long, the petioles and rachis somewhat angular; leaflets opposite, usually 10 or 11, firmly chartaceous, brownish and shining when dry, glabrous, somewhat inequilateral, oblong-ovate to oblong-lanceolate, 4 to 8 cm long, 2 to 3 cm wide, the apex acuminate, base acute or rounded; lateral nerves slender, indistinct, up to 15 on each side of the midrib, the reticulations obsolete or nearly so; petiolules 3 mm long or less. Inflorescences simple, solitary, spikelike, from the axils of fallen leaves, 4 to 5 cm long. Flowers sessile or subsessile, 4-merous, 5 to 6 mm long. Calyx shallowly cup-shaped, about

3 mm in diameter, 4-toothed, the teeth broad, subacute or obtuse, about 1 mm long. Petals oblong, obtuse, free, 5 mm long, 2 mm wide, puberulent externally. Staminal tube oblong, cylindric, or obscurely angled, 4 mm long, glabrous on both sides, crenate. Stamens 8, about 0.7 mm long. Disk annular, about 1 mm high and 1.5 mm in diameter. Ovary 4-celled, pubescent as is the base of the style, the ovary and style together about 3 mm long.

PANAY, Capiz Province, Mount Salibongbong, *Bur. Sci. 35631 Martelino & Edaño,* June, 1919, in forests near the summit, altitude about 650 meters.

This species has somewhat the appearance of *Dysoxylum turczaninowii* C. DC. but is not closely allied to that species, differing essentially in its simple, spicate inflorescences; the leaflets are also much smaller than in the latter species.

**DYSOXYLUM SIARGAOENSE** sp. nov. § *Eudysoxylum.*

Arbor parva, partibus junioribus et inflorescentiis caulinis plus minusve pubescens; foliis alternis, circiter 35 cm longis, vetustioribus glabris, foliolis circiter 13, chartaceis, oppositis, oblongis ad oblongo-lanceolatis, plerumque inaequilateralibus, 10 ad 15 cm longis, acuminatis, nervis utrinque circiter 15, tenuibus; racemis caulinis, fasciculatis 1.5 ad 2.5 cm longis; floribus 4-meris, breviter pedicellatis, 5 mm longis, calycis circiter 2 mm diametro; petalis oblongis liberis, glabris; ovario pubescente.

A small tree, the younger parts and the cauline inflorescences more or less pubescent. Branches terete, brownish when dry, the ultimate ones about 7 mm in diameter, glabrous, the branchlets and very young leaves more or less pubescent. Leaves alternate, about 35 cm long, glabrous when mature, the leaflets about 13, opposite, chartaceous, oblong to oblong-lanceolate, usually inequilateral, olivaceous when dry, 10 to 15 cm long, 3.5 to 4.5 cm wide, acuminate, the base usually strongly inequilateral and acuminate, the lamina longer on one side than on the other, or the uppermost leaflets equilateral; lateral nerves about 15 on each side of the midrib, slender and anastomosing, the reticulations lax, distinct; petioles 6 mm long or less. Racemes fascicled on the larger branches, 1.5 to 2.5 cm long, cinereous-pubescent. Flowers 4-merous, about 5 mm long, their pedicels 1.5 to 2 mm in length. Calyx pubescent, somewhat cup-shaped, about 2 mm long and wide, broadly and irregularly 4-toothed. Petals 4, white, free, oblong to oblong-oblanceolate, about 5 mm long, 1.5 mm wide, glabrous or slightly pubescent at their apices outside. Staminal tube cylindric, toothed, glabrous on both surfaces, 3.5 mm long. Anthers usually 7, 0.8 mm long. Disk glabrous, free, about 1 mm high. Ovary and stigma about 4 mm long, the stigma 1 mm in diameter, the ovary pubescent, no thicker than the glabrous style.

SIARGAO, *Bur. Sci. 35021 Ramos & Pascasio,* May 27, 1919, in forests at low altitudes.

The alliance of this species is apparently with *Dysoxylum cumingianum* C. DC., but the mature leaves are glabrous while the flowers are very much smaller than in the latter species, there being further many other differential characters; the two are not closely allied.

## DICHAPETALACEAE

### DICHAPETALUM Thouars

**DICHAPETALUM NITIDUM** sp. nov.

Frutex scandens, ramulis et petiolis et inflorescentiis pubescens; foliis coriaceis, olivaceis, nitidissimis, oblongis ad oblongo-lanceolatis, 10 ad 14 cm longis, basi acutis vel obtusis, apice leviter acuminatis, nervis utrinque circiter 6, reticulis ultimis utrinque distinctis; cymis pedunculatis, 3 ad 4 cm longis, dense pubescens, petalis oblongo-obovatis, deorsum angustatis, 2 mm longis, apice retusis.

A woody vine, the branchlets, petioles, and inflorescences more or less pubescent with short, yellowish-brown or ferruginous hairs, the younger parts densely pubescent. Branches reddish-brown when dry. Leaves coriaceous, olivaceous and strongly shining when dry, oblong to oblong-lanceolate, 10 to 14 cm long, 2.5 to 4.4 cm wide, the base acute or obtuse, narrowed upward to the somewhat acuminate apex; lateral nerves about 6 on each side of the midrib, curved, anastomosing, distinct, the ultimate reticulations rather close, raised, and distinct on both surfaces; petioles about 1 cm long. Inflorescences peduncled, cymose, 3 to 4 cm long, dichotomously branched, up to 2 cm in diameter, the peduncles up to 2.5 cm long, the younger parts especially densely pubescent with short hairs. Pedicels about 1 mm long, twice as long as the lanceolate bracteoles. Flowers about 3.5 mm in diameter. Sepals densely pubescent, oblong, obtuse, 1.7 mm long. Petals glabrous, oblong-obovate, rounded, narrowed below, about 2 mm long, the apex minutely cleft for about 0.5 mm. Filaments about 1.2 mm long. Ovary densely lanate.

MINDANAO, Surigao Province, *Bur. Sci. 34596 Ramos & Pas-*

*casio*, April 24, 1919, at the iron deposit on the northeast coast on ridges at low altitudes.

This species apparently belongs in the group with *Dichapetalum timoriense* Engl. and seems to be sufficiently well characterized by its coriaceous leaves, the ultimate reticulations of which are rather close, raised, and distinct on both sides.

DICHAPETALUM OBLONGIFOLIUM sp. nov.

Frutex scandens, conspicue ciliatus; foliis chartaceis, oblongis, 8 ad 14 cm longis, in siccitate pallidis, basi acutis, sursum angustatis, apice obtuse acuminatis, nervis utrinque circiter 7, distinctis, reticulis laxis; cymis axillaribus, solitariis, brevissime pedunculatis, 1 ad 1.5 cm longis, sepalis dense pubescens, late ovatis, rotundatis, 2 mm longis, petalis oblongo-obovatis, apice retusis.

A woody vine, all parts ciliate with rather pale, spreading, more or less scattered hairs, the indumentum dense on the younger parts. Branches glabrous, grayish, about 3 mm in diameter, the younger branchlets rather densely ciliate. Leaves chartaceous, oblong, 8 to 14 cm long, 2 to 3.5 cm wide, rather pale when dry, the base acute, narrowed upward to the somewhat blunt-acuminate apex, both surfaces prominently ciliate with long, scattered hairs; lateral nerves about 7 on each side of the midrib, curved, distinct, the reticulations lax; petioles densely villous, 3 to 5 mm long. Cymes axillary, solitary, short-peduncled, dichotomous, 1 to 1.5 cm long, densely ciliate. Flowers white, 4 to 5 mm in diameter, their pedicels 2 mm long or less, the bracts lanceolate, acuminate, up to 3 mm in length, the bracteoles linear. Sepals densely pubescent, broadly ovate, rounded, 2 mm long. Petals 5, thin, oblong to narrowly oblong-obovate, about 1.8 mm long, the apex cleft for 0.5 mm or less. Filaments stout, about 1 mm long, the anthers about as long as the filaments.

BUCAS GRANDE, *Bur. Sci. 35044 Ramos & Pascasio*, June 6, 1919, in thickets along streams at low altitudes.

A species manifestly allied to *Dichapetalum ciliatum* Merr., but with longer, differently shaped leaves which are prominently ciliate on both surfaces.

DICHAPETALUM HOLOPETALUM sp. nov.

Frutex scandens, partibus junioribus et foliis et inflorescentiis perspicue ciliatis; foliis membranaceis, oblongo-ellipticis, 10 ad 18 cm longis, basi acutis, apice tenuiter acuminatis, nervis utrinque circiter 6, perspicuis, reticulis laxis; cymis axillaribus, breviter pedunculatis, densis, subglobosis, circiter 1 cm diametro, petalis anguste spatulatis, 2 mm longis, integris; capsulis ellipsoideis, compressis, dense pubescens, 1.4 ad 2 cm longis, retusis.

A woody vine, the younger parts, leaves, and inflorescences prominently ciliate, the hairs spreading. Branches reddish brown, somewhat lenticellate, glabrous, the branchlets conspicuously ciliate. Leaves membranaceous, greenish when dry, oblong-elliptic, 10 to 18 cm long, 3.5 to 7 cm wide, narrowed below to the acute base and above to the rather slenderly acuminate apex, rather prominently ciliate on both surfaces or the upper surface ultimately glabrous; lateral nerves about 6 on each side of the midrib, prominent, the reticulations lax; petioles ciliate, 4 to 7 mm long. Cymes axillary, dense, subglobose, about 1 cm in diameter, short-penduncled. Sepals elliptic-ovate to elliptic-obovate, pubescent, 2 to 2.5 mm long. Petals glabrous, somewhat fleshy, not cleft, narrowly spatulate, about 2 mm long. Filaments about 2 mm long. Ovary villous. Capsules ellipsoid, compressed, 1.4 to 2 cm long, densely pubescent, normally retuse at the apex with a median dividing line, 2-seeded.

MINDANAO, Lanao District, Camp Keithley, *Mrs. Clemens 1039*, May and June, 1907 (type); Kolambugan, *For. Bur. 23320 Agama*, December 3, 1914; Tutunod, *For. Bur. 23382 Acuña*, December 12, 1914. In thickets at low altitudes, ascending to at least 670 meters.

A species in many respects resembling *Dichapetalum ciliatum* Merr. but distinguishable, among other characters, by its petals being entire and not cleft at their apices.

## ANACARDIACEAE

### SEMECARPUS Linnaeus

**SEMECARPUS SURIGAENSIS** sp. nov.

Arbor, circiter 8 m alta, inflorescentiis exceptis glaber, ramis circiter 8 mm diametro; foliis subcoriaceis, oblongo-ellipticis, nitidis, subtus pallidioribus, circiter 35 cm longis et 15 cm latis, basi acutis, apice breviter acuminatis, nervis utrinque circiter 22, valde perspicuis; inflorescentiis ♂ circiter 50 cm longis, multifloris, pubescens; floribus, subfasciculatis, sessilibus, 5 ad 6 mm diametro, sepalis et petalis extus dense ferrugineo-pubescens.

A tree, about 8 m high, the inflorescences and flowers ferruginous-pubescent, otherwise glabrous or nearly so. Branches terete, glabrous, the ultimate ones about 8 mm in diameter, brownish, the very young branchlets slightly pubescent. Leaves oblong-elliptic, subcoriaceous, rather pale and shining when dry, the lower surface paler than the upper, but scarcely glaucous, about 35 cm long and 15 cm wide, the base acute, the apex abruptly acuminate, the acumen usually about 1 cm long; lateral nerves about 22 on each side of the midrib, very prominent on the lower surface, the reticulations distinct, the primary ones leaving the nerves at about right angles; petioles 2 to 3 cm long. Staminate panicles terminal, about 50 cm long, many-flowered, the lower branches up to 30 cm long. Flowers somewhat fascicled on the branchlets, rather densely ferruginous-pubescent, sessile or with very short pedicels, 5 to 6 mm in diameter. Calyx about 3 mm in diameter, the lobes triangular, acute, about 1 mm long. Petals oblong-lanceolate, acute, 2.8 mm long, densely ferruginous-pubescent externally. Filaments 1.5 to 3 mm long.

MINDANAO, Surigao Province, *Bur. Sci. 34772 Ramos & Pascasio,* June 19, 1919, along streams at low altitudes.

This species is well characterized by its ample, glabrous leaves, and its very large, ferruginous-pubescent panicles. It is apparently most closely allied to the Moluccan *Semecarpus cassuvium* Roxb. and has no close allies among the known Philippine species.

## AQUIFOLIACEAE

### ILEX Linnaeus

**ILEX CURRANII** sp. nov. § *Euilex, Rugosae.*

Arbor parva, glabra, circiter 3 m alta; foliis eglandulosis, numerosis, coriaceis, olivaceis, nitidis, ovatis, 1 ad 1.5 cm longis, basi acutis ad rotundatis, sursum angustatis, apice breviter acuminatis, margine crenatis, nervis utrinque circiter 6, subtus cum reticulis prominulis; floribus axillaribus, fasciculatis vel solitariis, 4-meris, calycis lobis leviter ciliatis; fructibus globosis, 5 mm diametro, pyrenis 4.

A glabrous shrub, or small tree, about 3 m high, the branches rather pale, the branchlets nearly black when dry. Leaves coriaceous, ovate, 1 to 1.5 cm long, 7 to 12 mm wide, olivaceous, shining, not glandular, the base acute to rounded, the apex shortly and bluntly acuminate, margins distinctly crenate, the crenulations often with an indurated, incurved tip; lateral nerves about 6 on each side of the midrib, somewhat impressed on the upper surface, distinct on the lower surface as are the reticulations; petioles 2 to 4 mm long. Fruits subglobose, about 5 mm in diameter, somewhat rugose and nearly black when dry, containing 4 pyrenes, the persistent calyx about 2 mm in diameter, obscurely 4-lobed, lobes slightly ciliate, the pedicels up to 4 mm in length. Flowers axillary, solitary or sometimes two or three in a fascicle, the pedicels subtended by several small bracts.

LUZON, Benguet Subprovince, Mount Pulog, *For. Bur. 18069 Curran, Merritt, & Zschokke,* January 6, 1908, on slopes in the mossy forest, altitude about 2,500 meters.

This species apparently belongs in the group with *Ilex rugosa* Schmidt and is well characterized by its small, ovate, rather distinctly nerved and reticulate, eglandular leaves. In general appearance it resembles *Ilex buergeri* Miq., but it has much smaller leaves.

**ILEX PAUCINERVIA** sp. nov. § *Thyrsoprinus, Indico-Malaicae.*

Frutex vel arbor parva glabra; foliis integris, coriaceis, oblongo-ellipticis ad oblongis, usque ad 4 cm longis, eglandulosis, supra minutissime puncticulatis, utrinque aequaliter angustatis, basi acutis, apice obtusis retusisque, in siccitate castaneis vel brunneis, nitidis, nervis utrinque 4 vel 5, reticulis obsoletis; inflorescentiis racemosis, axillaribus, solitariis, 5- ad 10-floris, floribus 5-meris; fructibus circiter 3 mm diametro.

A glabrous shrub or small tree, the branches and branchlets grayish yellow or the very young parts sometimes reddish brown. Leaves numerous, coriaceous, oblong-elliptic to oblong, 2 to 4 cm long, 10 to 18 mm wide, not glandular, the upper surface very minutely pitted, brown or castaneous and somewhat shining when dry, entire, subequally narrowed to the acute base and to the obtuse and distinctly retuse apex; lateral nerves slender, somewhat ascending, 4 or 5 on each side of the midrib, not prominent, arched-anastomosing, the reticulations obsolete or nearly so; petioles 2 to 4 mm long. Racemes axillary, solitary, usually about 1 cm long, 5- to 10-flowered; flowers 5-merous, their pedicels about 2 mm long. Fruits brown, ovoid or globose, about 3 mm in diameter, each containing 5 pyrenes, the persistent calyx about 2 mm in diameter, the lobes suborbicular, rounded, entirely glabrous.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26396 Ramos & Edaño,* August 19, 1916, in forest at the summit, altitude probably about 1,000 meters. This number was originally identified as *Ilex brunnea* Merr.

This species is well characterized by its oblong-elliptic to oblong leaves which are eglandular but which are minutely pitted on the upper surface and are further subequally narrowed to the acute base and to the obtuse and retuse apex. It is somewhat similar to *Ilex microthyrsa* Loesen, but has very differently shaped leaves.

## CELASTRACEAE

### MICROTROPIS Wallich

**MICROTROPIS ROSTRATA** sp. nov.

Frutex glaber, ramulis rubro-brunneis, laevis; foliis oblongis ad late oblongo-lanceolatis, chartaceis, usque ad 20 cm longis, utrinque acutis vel leviter acuminatis, nervis primariis utrinque circiter 12, tenuibus, distinctis, floribus 5-meris; infructescentiis axillaribus, brevibus, cymosis, fructibus oblongis, circiter 2 cm longis, perspicue rostrato-acuminatis.

An erect glabrous shrub, the branches and branchlets terete, smooth, reddish-brown, the latter about 2.5 mm in diameter. Leaves opposite, chartaceous, pale and shining when dry, oblong to broadly oblong-lanceolate, 17 to 20 cm long, 5 to 6 cm wide, narrowed to the acute or somewhat acuminate base and apex; primary lateral nerves about 12 on each side of the midrib, slender, distinct, anastomosing, the reticulations lax; petioles about 1 cm long. Infructescences axillary, or sometimes terminating short lateral branchlets, usually solitary, cymose, peduncled, the peduncles 1 cm long or less. Fruits greenish-yellow when fresh, reddish-brown when dry, oblong, about 2 cm long and 8 mm in diameter, the apex prominently rostrate-acuminate. Persistent sepals 5, broadly ovate, rounded, about 2 mm long, the calyx 6 mm in diameter.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33568 Ramos & Edaño,* November 29, 1918, in damp forests at low altitudes.

The alliance of this species is with *Microtropis philippinensis* Merr., from which it is distinguished by its larger leaves, more numerous lateral nerves and more prominently acuminate fruits.

## HIPPOCRATEACEAE

### HIPPOCRATEA Linnaeus

**HIPPOCRATEA ELLIPTICARPA** sp. nov.

Frutex scandens, glaber; foliis ellipticis ad elliptico-ovatis, crasse coriaceis, 15 ad 20 cm longis, nitidis, supra olivaceis, subtus brunneis, nervis utrinque 7, perspicuis; fructibus ellipticis, utrinque rotundatis, ligneis, 7 cm longis et 4 cm latis.

A scandent, glabrous vine, the branches somewhat reddish-brown, lenticellate, the ultimate ones 4 to 5 mm in diameter. Leaves elliptic to elliptic-ovate, thickly coriaceous, 15 to 20 cm long, 10 to 12 cm wide, shining, the upper surface olivaceous, the lower surface somewhat brownish, base rounded, apex rounded to shortly and obtusely acuminate; lateral nerves about 7 on each side of the midrib, prominent, curved, the reticulations distinct; petioles about 1 cm long. Infructescences woody, about 6 cm long, trichotomous, each branch bearing 2 or 3 capsules. Mature fruits brownish, elliptic, rounded at both ends, somewhat woody, about 7 cm long and 4 cm wide.

MINDANAO, Surigao Province, *Bur. Sci. 34761 Ramos & Pascasio,* May 18, 1919, in dry forests at low altitudes.

The alliance of this species is with *Hippocratea megalocarpa* Merr., from which it is especially distinguished by its larger and more-numerously nerved leaves and its differently shaped, shorter fruits.

## ICACINACEAE

### GOMPHANDRA Wallich

**GOMPHANDRA OBLONGIFOLIA** sp. nov.

Arbor glabra, usque ad 10 m alta; foliis chartaceis, oblongo-ellipticis ad oblongis, olivaceis, nitidis; 9 ad 15 cm longis, utrinque subaequaliter angustatis, basi acutis, apice acuminatis, nervis utrinque 5 vel 6, reticulis obsoletis vel subobsoletis; cymis plerumque terminalibus oppositifoliisque, usque ad 4 cm longis; fructibus ellipsoideis, 1.5 ad 1.8 cm longis.

A tree, up to 10 m high, glabrous except the somewhat pubescent inflorescences. Leaves chartaceous, oblong-elliptic to oblong, olivaceous, when dry shining, the lower surface paler than the upper, 9 to 15 cm long, 3.5 to 6 cm wide, subequally narrowed to the acute base and to the more or less acuminate apex; lateral nerves 5 or 6 on each side of the midrib, distinct, obscurely anastomosing, the reticulations obsolete or nearly so; petioles about 1 cm long. Cymes solitary, peduncled, sparingly pubescent, leaf-opposed, mostly at the tips of the ultimate branchlets, in fruit up to 4 cm long. Fruit ellipsoid to oblong-ellipsoid, 1.5 to 1.8 cm long, brown when dry, faintly ridged or sulcate.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33727 Ramos & Edaño* (type), *For. Bur. 27403 Alambra;* Lagonoy, *For. Bur. 21103 Hsia.* CATANDUANES, *Bur. Sci. 30258, 30355 Ramos.* In dipterocarp forests at low altitudes, fruiting in December and in April.

This species somewhat resembles *Urandra luzoniensis* Merr., which I now consider to belong in the genus *Gomphandra,* and the specimens cited above were originally so identified. The present species differs from *Urandra luzoniensis* in its oblong to oblong-elliptic, more-numerously nerved leaves which are subequally narrowed to both base and apex and which do not approach the obovate type. It is possible that *Bur. Sci. 35264 Ramos & Pascasio* from Dinagat Island is referable to the same species. In this specimen the cymes are axillary and also from the axils of fallen leaves, while the leaves are relatively narrower and subcaudate-acuminate. The extra-Philippine alliance of the species seems to be with *Gomphandra lanceolata* King, of the Malay Peninsula.

**GOMPHANDRA LANCIFOLIA** sp. nov.

Arbor parva, glabra, foliis lanceolatis, brunneo-olivaceis, nitidis, chartaceis vel subcoriaceis, 7 ad 9 cm longis, utrinque subaequaliter angustatis, apice tenuiter subcaudato-acuminatis, nervis utrinque 3, tenuibus, reticulis obsoletis; fructibus carnosis, oblongo-obovoideis ad oblanceolatis, 2.5 ad 3 cm longis, mesocarpio leviter sulcato.

A glabrous tree, about 6 m high. Leaves lanceolate, chartaceous or subcoriaceous, brownish-olivaceous and somewhat shining when dry, 7 to 9 cm long, 1.5 to 2.5 cm wide, subequally narrowed to the cuneate or somewhat acuminate base and to the slenderly subcaudate-acuminate apex, the acumen usually about 1 cm long; lateral nerves usually 3 on each side of the midrib, distant, curved-ascending, slender, the reticulations nearly obsolete; petioles 5 to 7 mm long. Fruits axillary, their peduncles up to 1 cm long, fleshy, oblong-obovate to oblanceolate, salmon-colored, 2.5 to 3 cm long, the mesocarp somewhat longitudinally ridged.

LUZON, Tayabas Province, Mount Dingalan, on the east coast, on dry forested slopes, altitude about 300 meters, locally known to the Negritos as *paranuyog*.

A species well characterized by its lanceolate, subcaudate-acuminate, few-nerved leaves which are subequally narrowed to both base and apex, as well as by its rather large fruits. It is probably as closely allied to *Stemonurus fuliginea* Elm., which belongs in *Gomphandra,* as to any other described species.

**GOMPHANDRA GLABRA** sp. nov.

Arbor, circiter 10 m alta, ramulis junioribus inflorescentiisque parcissime pubescentibus exceptis glabra; foliis oblongis, membranaceis, usque ad 11 cm longis, in siccitate nitidis, olivaceo-brunneis, acutis vel leviter acuminatis, basi subacutis, nervis utrinque circiter 10, subtus perspicuis; cymis axillaribus, paucifloris, usque ad 3.5 cm longis; fructibus oblongis, inaequilateralibus, glabris, usque ad 8 mm longis.

A tree, about 10 m in height, glabrous except the very tips of the branchlets and the cymes which are sparingly appressed-pubescent. Branches terete, grayish, smooth, the branchlets reddish brown, slender. Leaves alternate, oblong, membranaceous, 9 to 11 cm long, 3.5 to 4 cm wide, brownish-olivaceous, of the same color and shining on both surfaces when dry, the apex acute to slightly acuminate, minutely apiculate, base subacute; lateral nerves about 10 on each side of the midrib, slender but prominent on the lower surface, curved-anastomosing, the reticulations distinct, lax; petioles 8 to 10 mm long. Cymes axillary, solitary, peduncled, lax, apparently few-flowered, up to 3.5 cm long, in age white-glabrous, but in flower slightly appressed-pubescent. Fruits oblong, up to 8 mm long, glabrous, the pericarp somewhat fleshy, prominently gibbous on one side.

SAMAR, Yabong, *Phil. Pl. 1628 Merrill* (type), April, 1914, on forested slopes; Catubig River, *Bur. Sci. 24241, 24547 Ramos,* March 10, 1916, *Sablaya 16;* Cauayan Valley, *Bur. Sci. 17660 Ramos,* March, 1914. LEYTE, *Wenzel 1029, 1722, 1744.* In primary forests at low altitudes.

Similar and closely allied to *Gomphandra cumingiana* F.-Vill., differing in being almost entirely glabrous, and in its somewhat differently shaped, more-numerously nerved leaves.

### GONOCARYUM Miquel

**GONOCARYUM GRANDIFOLIUM** sp. nov.

Arbor parva, glabra; foliis coriaceis, late elliptico-ovatis, 25 ad 28 cm longis, circiter 18 cm latis, nitidis, basi late rotundatis, apice breviter obtuse acuminatis, nervis utrinque circiter 4, perspicuis; floribus sessilibus, 6 ad 7 mm longis, fasciculatis, fasciculis in axillis defoliatis, paucifloris; sepalis suborbicularibus, 1 ad 1.5 mm diametro, leviter pubescens.

A glabrous tree, at least 5 m high. Leaves coriaceous, broadly elliptic-ovate, 25 to 28 cm long, about 18 cm wide, shining when dry, base broadly rounded, the apex shortly and bluntly acuminate; lateral nerves about 4 on each side of the midrib, the primary reticulations very lax; petioles stout, about 2 cm long. Flowers sessile, fascicled in the axils of fallen leaves, 6 to 7 mm long. Calyx lobes suborbicular, slightly pubescent, 1 to 1.5 mm in diameter. Corolla white, glabrous, the lobes oblong, acute, 1.5 to 2 mm long. Ovary ovoid, the style cylindric, stout, 1.2 mm in length.

DINAGAT, *Bur. Sci. 35205 Ramos & Pascasio,* May 11, 1919, in forests along small streams at low altitudes.

This species is especially characterized by its large leaves and its fascicled flowers, in these characters being readily distinguished from its ally *Gonocaryum calleryanum* Becc.

## SAPINDACEAE

### GUIOA Cavanilles

**GUIOA BICOLOR** sp. nov.

Arbor parva, partibus junioribus leviter pubescens; foliis 25 ad 30 cm longis, foliolis plerumque 9, crasse coriaceis, oblongo-ovatis ad oblongo-ellipticis, 9 ad 12 cm longis, acute acuminatis, subtus glaucescentibus; paniculis axillaribus usque ad 15 cm longis, leviter pubescens; floribus numerosis, petalis anguste obovatis, 1.5 mm longis, appendiculis villosis, petalis subaequantibus.

A small tree, the younger parts sparingly pubescent, the older parts glabrous. Branchlets dark reddish-brown or nearly black when dry. Leaves 25 to 30 cm long, the leaflets usually 9, thickly coriaceous, oblong-ovate to oblong-elliptic, 9 to 12 cm long, 3.5 to 5.5 cm wide, the base somewhat inequilateral, the apex rather sharply acuminate, the upper surface brownish when dry, glabrous, shining, the lower surface glaucous and sparingly pubescent with short, widely scattered hairs; lateral nerves about 9 on each side of the midrib, distinct, the reticulations not prominent; petiolules up to 1 cm in length, their bases much thickened. Panicles axillary, up to 15 cm long, branched from the base, very slightly pubescent. Flowers white, numerous; sepals unequal, 2 to 2.5 mm long. Petals narrowly obovate, 1.5 mm long, their margins slightly ciliate, the villous scales about as long as the petals.

MINDANAO, Surigao Province, *Bur. Sci. 34487 Ramos & Pascasio,* April 25, 1919, at the iron deposit on the northeast coast, on ridges, altitude about 780 meters.

This species is rather radically different from the previously described Philippine representatives of the genus in its thickly coriaceous leaflets which are glaucous on the lower surface.

## VITACEAE

### TETRASTIGMA Planchon

**TETRASTIGMA MINDANAENSE** sp. nov.

Frutex scandens, partibus junioribus inflorescentiisque pubescens; foliis 3-foliolatis, foliolis chartaceis, ellipticis ad ovato-ellipticis, 10 ad 13 cm longis, usque ad 7 cm latis, basi rotundatis, apice abrupte acuminatis, marginae distanter dentatis, dentibus apiculatis; inflorescentiis pubescens, circiter 10 cm longis, ramis primariis paucis, floribus umbellatim dispositis; petalis oblongo-ovatis, obtusis vel acutis, obscure cucullatis, haud corniculatis, 2 mm longis, pubescens.

A vine, the younger parts and inflorescences rather distinctly pubescent or puberulent, the branches terete, glabrous, about 3 mm in diameter, the younger ones more or less pubescent. Leaves 3-foliolate, their petioles about 4 cm long and with 1- to 2-cm long petiolules, somewhat pubescent; leaflets chartaceous when dry, olivaceous, elliptic to ovate-elliptic, 10 to 13 cm long, 5 to 7 cm wide, base rounded, often somewhat inequilateral, apex abruptly acuminate, the margins distantly toothed, the teeth rather coarsely apiculate; lateral nerves slender, distinct, about 8 on each side of the midrib. Inflorescences pubescent, about 10 cm long, the primary branches few, the secondary and tertiary ones umbellately arranged, the flowers umbellate at the tips of the ultimate branchlets, their pedicels 3 to 5 mm long, pubescent, primary branches subtended by broadly ovate, pubescent bracts, about 3 mm in length; petals 4, oblong-ovate, obtuse or acute, obscurely cucullate at their apices but not at all corniculate, about 2 mm long, pubescent externally. Ovary glabrous, ovoid, the stigma obscurely lobed.

MINDANAO, Surigao Province, *Bur. Sci. 34463 Ramos & Pascasio,* April, 1919, in damp forests at low altitudes.

The alliance of this species is apparently with *Tetrastigma loheri* Gagnep., but the inflorescences are much more ample, while the leaflets are much broader and very differently shaped than in Gagnepain's species.

## LEEA Royen

### LEEA PLATYPHYLLA sp. nov.

Frutex erectus, glaber; foliis pinnatis, circiter 70 cm longis, plerumque 7-foliolatis, foliolis circiter 34 cm longis et 14 cm latis, oblongis ad oblongo-ovatis, basi late acutis vel subrotundatis, apice acuminatis, nervis utrinque circiter 18, perspicuis; inflorescentiis sessilibus, ovoideis, densis, subcapitatis, circiter 2.5 cm longis; floribus numerosis, confertis, 4-meris, calycis 4 mm longis, petalis (partibus liberis) 3.5 mm longis; fructibus globosis, carnosis, circiter 1.5 cm diametro.

A glabrous shrub, the ultimate branches about 1.5 cm in diameter. Leaves simply pinnate, about 70 cm long, usually 7-foliolate; leaflets about 34 cm long and 14 cm wide, subcoriaceous, brownish when dry, oblong to oblong-ovate, the base broadly acute or somewhat rounded, the apex distinctly acuminate, the margin rather coarsely toothed except near the base; lateral nerves about 18 on each side of the midrib, very prominent, the primary reticulations distinct, subparallel; petiolules stout, 1 to 1.5 cm long. Inflorescences dense, ovoid, sessile, about 2.5 cm long, the flowers greenish-yellow, 4-merous, their petals up to 5 mm in length. Calyx about 5 mm long, cup-shaped, broadly 4-lobed. Petals oblong-ovate, about 3.5 mm long and 3 mm wide, the tube extended 2.5 to 3 mm above the attachment of the petals, the anthers narrowly oblong, 2 to 2.5 mm long. Fruit fleshy, globose, glabrous, red, about 1.5 cm in diameter, 1- or 2-seeded, the seeds subglobose, about 7 mm thick.

MINDANAO, Surigao Province, *Bur. Sci. 34397 Ramos & Pascasio,* April 30, 1919, in damp forests at low altitudes.

A species belonging in the group with *Leea congesta* Elm., but with very much larger, more-numerously nerved leaflets.

**LEEA CAPITATA** sp. nov.

Frutex erectus, glaber; foliis pinnatis, usque ad 90 cm longis, plerumque 11-foliolatis, foliolis oblongis ad oblongo-lanceolatis, coriaceis, 23 ad 36 cm longis, 5 ad 10 cm latis, basi late rotundatis, apice tenuiter acuminatis, nervis utrinque circiter 16, perspicuis; inflorescentiis ovoideis vel subglobosis, densis capitatis, 3 ad 4 cm diametro; floribus confertis, 4-meris, calycis circiter 5 mm longis, petalis (partibus liberis) circiter 4 mm longis.

An erect, glabrous shrub, 1 to 2 m high, the ultimate branches up to 1.5 cm in diameter. Leaves simply pinnate, up to 90 cm long, usually 11-foliolate; leaflets oblong to oblong-lanceolate, coriaceous, 23 to 36 cm long, 5 to 10 cm wide, olivaceous when dry, the base rather broadly rounded, the apex slenderly acuminate, the acumen up to 2.5 cm long, margins rather coarsely toothed; lateral nerves about 16 on each side of the midrib, prominent, the reticulations subparallel; petiolules stout, 1 to 4 cm long. Inflorescences sessile, ovoid or subglobose, very dense, 3 to 4 cm in diameter. Flowers numerous, crowded, white, 4-merous, their pedicels up to 5 mm in length. Calyx cup-shaped, about 5 mm long, irregularly 3- or 4-lobed. Petals oblong-ovate, about 4 mm long, 2 to 3 mm wide, reflexed, the tube projecting about 3 mm above the insertion of the petals. Anthers 4, elliptic, about 2 mm long.

LUZON, Tayabas Province, Mount Cadig, Mount Pular, and Mount Binuan, three localities on the east coast, *Bur. Sci. 19430 Ramos, Bur. Sci. 28506 Ramos & Edaño, Bur. Sci. 25502 Yates,* in flower December to May. In damp forests along small streams at low and medium altitudes.

The alliance of this species is with *Leea congesta* Elm., from which it is readily distinguished by its much larger and fewer-nerved leaflets which are broadly rounded at the base; it is distinguished from *Leea platyphylla* especially by its fewer, differently shaped, relatively much narrower leaflets.

LEEA LONGIPETIOLATA sp. nov.

Frutex, circiter 1 m altus, glaber; foliis unifoliolatis, longe petiolatis, chartaceis vel subcoriaceis, oblongis ad oblongo-ellipticis, utrinque acutis, usque ad 30 cm longis, margine grosse sinuato-dentatis, nervis utrinque circiter 11, subtus perspicuis, curvatis; petiolo circiter 9 cm longo; infructescentiis in axillis superioribus, circiter 4 cm longis, sparce ramosis; fructibus carnosis, subglobosis, circiter 1.5 cm diametro, seminibus 2 vel 3.

An erect shrub, about 1 m high, glabrous throughout, the ultimate branches terete, dark brown, nearly smooth, about 4 mm in diameter. Leaves simple, oblong to oblong-elliptic, chartaceous to subcoriaceous, olivaceous and somewhat shining when dry, the lower surface paler than the upper, 22 to 30 cm long, about 11 cm wide, base and apex acute, margins rather coarsely sinuate-dentate; lateral nerves about 11 on each side of the midrib, prominent on the lower surface, curved, anastomosing close to the margin, the reticulations subparallel, distinct; petioles about 9 cm long. Infructescences in the upper axils, about 4 cm long, sparingly branched. Fruits fleshy, globose or subglobose, reddish when fresh, dark brown when dry, each with 2 or 3 globose seeds.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33633 Ramos & Edaño,* December 11, 1918, in damp forests at low altitudes.

This species belongs in the group with *Leea acuminatissima* Merr. and *L. unifoliolata* Merr. and is closely allied to both of these, from which it is readily distinguished by its larger leaves and very much longer petioles.

LEEA RAMOSII sp. nov.

Frutex erectus, inflorescentiis laxis, cinereo-pubescens; foliis circiter 60 cm longis, bipinnatis, pinnis paucis, plerumque 5-foliolatis; foliis chartaceis, ellipticis ad oblongo-ellipticis; 12 ad 22 cm longis, basi plerumque late rotundatis, apice subabrupte tenuiter acuminatis, nervis utrinque circiter 12, perspicuis, subtus ad costa leviter fasciculato-ciliatis; inflorescentiis usque ad 20 cm longis; floribus 5-meris, subalbidis, sessilibus, 5-meris, circiter 5.5 mm longis; fructibus depresso-globosis, 6 ad 8 mm diametro.

An erect shrub, about 2.5 m high, the inflorescences cinereous-pubescent, the leaflets with few, scattered, somewhat tufted cilia on the midrib beneath, the ultimate branches about 8 mm in diameter. Leaves bipinnate, about 60 cm long, the pinnae few, the lower ones usually 5-foliolate; leaflets chartaceous, elliptic to oblong-elliptic, 12 to 22 cm long, 6 to 10 cm wide, the base usually broadly rounded, the apex rather abruptly acuminate, the acumen slender, blunt, 1 to 1.5 cm long, margins distinctly toothed; lateral nerves prominent, about 12 on each side of the midrib, the reticulations distinct; petiolules 5 to 15 mm long. Inflorescences lax, branched from near the base, up to 20 cm long and as wide as or somewhat wider than long, the branches few, spreading. Flowers 5-merous, numerous, white or somewhat yellowish, sessile or subsessile and somewhat crowded at the tips of the ultimate branchlets, about 5.5 mm long. Calyx cup-shaped, 2.5 mm long, 5-lobed, the lobes broadly ovate, about 1 mm in length, glabrous. Petals oblong, 3 mm long, obtuse to acute, recurved. Anthers 1.2 mm long. Fruits depressed-globose, red when fresh, dark brown when dry, 6 to 8 mm in diameter, obscurely 5- or 6-sulcate when dry.

MINDANAO, Surigao Province, *Bur. Sci. 34550 Ramos & Pascasio*. SIARGAO, *Bur. Sci. 34945* (type), *34907 Ramos & Pascasio*, May 27, 1919, in thickets and forests at low altitudes.

This species in general appearance is not radically different from *Leea indica* (Burm. f.) Merr. and several other species allied to the latter. The scattered ciliate hairs on the midrib beneath are a distinguishing character.

## STERCULIACEAE

### STERCULIA Linnaeus

**STERCULIA GLABRIFOLIA** sp. nov.

Arbor glabra, vel ramulis junioribus leviter pubescens, ramis circiter 5 mm diametro; foliis subcoriaceis, oblongis ad oblongo-ellipticis, integris, 8 ad 22 cm longis, breviter obtuse acuminatis, basi late rotundatis et distincte cordatis, nervis utrinque 8 ad 12, perspicuis; petiolo 4 ad 7 cm longo; inflorescentiis ♂ solitariis, glabris, axillaribus, anguste paniculatis, circiter 12 cm longis, paucifloris; floribus 4-meris, extus glabris, intus dense villosis, alabastro 7 ad 8 mm longo, lobis acutis, liberis.

A tree, about 5 m high, entirely glabrous except the very young tips of the branchlets and the inside of the calyx. Branches terete, rugose when dry, the ultimate ones about 5 mm in diameter, the very tips of the branchlets sparingly ferruginous-pubescent. Leaves subcoriaceous, oblong to oblong-elliptic, 8 to 22 cm long, 4 to 10 cm wide, entire, the apex shortly blunt-acuminate, the base broadly and abruptly rounded and rather deeply cordate; lateral nerves 8 to 12 on each side of the midrib, prominent, obscurely anastomosing, sparingly bearded on the axils on the lower surface; petioles 4 to 7 cm long. Staminate inflorescences axillary, solitary, narrowly paniculate, about 12 cm long, the branches few, the lower ones 2 cm long or less, 2- or 3-flowered, the upper ones small and 1-flowered, the pedicels 1.5 to 2 cm long, slender. Staminate flowers 4-merous, the buds ovoid, about 7 to 8 mm long, the calyx glabrous externally except at the edges of the valvate lobes, the lobes broad, acute, irregular, apparently free at maturity, inside densely villous. Anthers many in a globose head.

MINDANAO, Surigao Province, Hegapit River, *Bur. Sci. 34517 Ramos & Pascasio,* April 23, 1919, in forests at low altitudes.

A very characteristic species, not closely related to any other one known to me, readily distinguished by its being nearly glabrous and by its oblong to oblong-elliptic, glabrous leaves which are broadly rounded and rather deeply cordate at the base.

## DILLENIACEAE

### SAURAUIA Willdenow

**SAURAUIA MINDORENSIS** sp. nov.

Arbuscula, circiter 3 m alta; foliis oblanceolato-ellipticis, chartaceis, circiter 25 cm longis, apice breviter abrupteque acuminatis, basi angustatis, acutis, supra glabris, nitidis, subtus pallide tomentosis nitidisque, nervis utrinque circiter 22; cymis axillaribus, brevibus, paucifloris, floribus circiter 2 cm diametro, calycis lobis setis patulis 2.5 ad 4.5 mm longis; obtectis.

A shrub, about 3 m high. Branches slender, glabrous, except for few scattered, appressed scales, the branchlets with numerous, appressed, acicular, 2 to 6 mm long scales. Leaves oblanceolate-elliptic, chartaceous, 20 to 24 cm long, about 8 cm wide, the upper surface dark-colored when dry, glabrous and somewhat shining, the lower surface densely pale ferruginous-tomentose, almost flesh-colored, the apex shortly and abruptly acuminate, the acumen apiculate, the leaf gradually narrowed in the lower half to the acute base, the margins prominently apiculate-dentate; nerves about 22 on each side of the midrib distinct beneath, obscurely anastomosing, the reticulations obscure; petioles

2.5 to 5 cm long, with few appressed setose scales. Cymes in the upper axils, few-flowered, shorter than the petioles. Outer sepals orbicular-ovate, very shortly acuminate, about 13 mm long and wide, more or less tomentose outside and densely covered with acicular spreading scales 2.5 to 4.5 mm long, the inner surface tomentose, the inner sepals smaller and setose only on the exposed portions. Ovary densely ferruginous-hirsute, ovoid; styles 5, free, in bud 2 mm long.

MINDORO, south of Lake Naujan, *For. Bur. 6849 Merritt*, April, 1907, in forests, at an altitude of about 100 meters.

A species well characterized by its chartaceous leaves which are entirely glabrous above and densely tomentose and shining beneath, the indumentum somewhat salmon- or flesh-colored; its short cymes; comparatively large flowers; densely setose calyx; and pubescent ovary.

**SAURAUIA TRUNCIFLORA** sp. nov.

Arbor parva, ramulis irregulariter adpresse setosis exceptis glabra; foliis oblanceolatis, chartaceis, 22 ad 35 cm longis, supra olivaceis laevis, apice breviter acuminatis, deorsum angustatis, basi cuneatis, margine serrulatis, nervis utrinque 15 ad 20, perspicuis, adscendentibus; inflorescentiis caulinis, floribus tenuiter pedicellatis, confertis, fasciculis usque ad 7 cm diametro; sepalis elliptico-ovatis, 5 ad 9 mm longis, glabris; ovario glabro; stylis 3, deorsum connatis.

A small tree, reaching a height of 5 m, the branches glabrous, the young branchlets with few to many, appressed, unequal, ovate to lanceolate, acuminate scales. Leaves oblanceolate, chartaceous, 22 to 35 cm long, 6 to 10 cm wide, the upper surface dark-olivaceous, smooth, the lower surface glabrous, apex acuminate, gradualy narrowed from above the middle to the cuneate base, the margins rather finely serrate; lateral nerves 15 to 20 on each side of the midrib, ascending, the reticulations lax, obscure or nearly obsolete; petioles 2 cm long or less. Flowers white, in dense fascicles from tubercles on the trunk, the fascicles up to 7 cm in diameter, the pedicels slender, somewhat furfuraceous, unbranched, 2 to 3.5 cm long, ebracteolate or with a pair of small bracteoles. Sepals glabrous or slightly furfuraceous, not at all setose, elliptic-ovate, 5 to 9 mm long, about 5.5 mm wide, the inner ones slightly exceeding the outer ones and subpetaloid. Petals about 10 mm long and 7 mm wide, the apex retuse. Stamens 20, the anthers 3 mm long. Ovary ovoid, glabrous; style about 4 mm long, the arms usually 3, free or somewhat united at the base.

MINDANAO, Lanao District, near Camp Keithley, *For. Bur. 3918 Hutchinson* (type), March 9, 1906, *Clemens 426,* March, 1906, *For. Bur. 25172 Alvarez,* March, 1916. In thickets and forests, altitude 700 to 1,000 meters.

A species strongly characterized by its glabrous, or nearly glabrous, oblanceolate leaves, and by its dense, fascicled, cauline inflorescences.

SAURAUIA LANAENSIS sp. nov.

Arbor parva, ramulis petiolisque adpresse setosis, foliis subtus ad costa nervisque adpresse-setulosis; foliis oblanceolatis, 11 ad 20 cm longis, tenuiter acuminatis, deorsum angustatis, basi cuneatis, margine spinulosis, supra glabris, laevis, nervis utrinque 10 ad 12, perspicuis, reticulis distinctis; cymis axillaribus, paucifloris quam petiolo brevioribus, plus minusve setosis; floribus parvis, sepalis leviter subadpresse-setosis, circiter 3 mm longis; ovario glabro; stylis 4, liberis.

A shrub or small tree, 3 to 5 m high, the branchlets appressed-setose with short, brown, lanceolate scales, the petioles and midrib on the lower surface with similar scales. Leaves chartaceous, oblanceolate, 11 to 20 cm long, 3 to 6 cm wide, the apex slenderly acuminate, narrowed to the cuneate base, the margins somewhat spinulose, the upper surface smooth, olivaceous, glabrous, the lower surface paler, appressed-setose with short scales on the midrib and lateral nerves; lateral nerves 10 to 12 on each side of the midrib, distinct, anastomosing, the reticulations evident; petioles 1 to 1.5 cm long. Inflorescences of very short, axillary, solitary or fascicled, few-flowered cymes usually 1 cm or less in length, the rachis and pedicels setose. Flowers white, small, the sepals elliptic-ovate to oblong-ovate, about 3 mm long and 2 mm wide, with few, slender, subappressed setae up to 1 mm in length. Petals narrowly oblong-obovate, about 5 mm long, 2.5 mm wide, the apex somewhat inequilaterally retuse. Anthers about 1.2 mm long. Ovary ovoid, glabrous; styles 4, free, 2 to 2.5 mm long.

MINDANAO, Lanao District, Camp Keithley, *Mrs. Clemens 868,* collected at various times on the forested slopes of Sacred Mountain, altitude about 800 meters: Misamis Province, Mount Malindang, *For. Bur. 4683 Mearns & Hutchinson,* May, 1906, in forests, altitude about 700 meters.

Among the Philippine forms this species is well characterized by its oblanceolate, slenderly acuminate leaves, and its short, few-flowered, axillary cymes, and small flowers.

## OCHNACEAE

### OURATEA Aublet

**OURATEA MINDANAENSIS** sp. nov.

Arbor parva, glabra; foliis oblongis, coriaceis, 7 ad 11 cm longis, basi rotundatis, apice acutis vel leviter acuminatis, distincte serratis, dentibus tenuiter apiculatis, nervis primariis quam secondariis haud distinctioribus; inflorescentiis terminalibus, floribus umbellatim dispositis, umbellis 2 vel 3; sepalis 3 vel 4, ellipticis ad oblongo-ellipticis rotundatis, 6 ad 7 mm longis; staminibus 8 ad 10, antheris 3 mm longis.

A small glabrous tree, about 4 m high, the branches brownish, slender, terete. Leaves oblong, coriaceous, 7 to 11 cm long, 2 to 4 cm wide, the base rounded, apex acute to somewhat acuminate, margins distinctly toothed, the teeth slenderly apiculate, pointing upward, the upper surface brownish-olivaceous and strongly shining when dry, the lower surface paler and slightly shining; primary lateral nerves scarcely more distinct than are the secondary ones, curved, not prominent, anastomosing, and forming 1 or 2 more or less distinct marginal nerves; petioles up to 5 mm in length. Inflorescences terminal, consisting of 2 or 3 peduncled, umbellike cymes, the peduncles less than 1 cm long, the bracts oblong, about 2.5 mm in length. Flowers few, their pedicels up to 1.5 cm long. Sepals 3 or 4, elliptic to oblong-elliptic, rounded, 6 to 7 mm long. Petals similar to the sepals but thinner, usually 3 or 4. Stamens 8 to 10, their filaments 1 mm long, the anthers linear, 3 mm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34479 Ramos & Pascasio,* April 25, 1919, along streams at low altitudes at the iron deposit on the northeast coast.

In general this species is similar to *Ochna fascicularis* Blanco, but by definition it belongs in the genus *Ouratea* and may be readily distinguished from Blanco's species not only by its floral characters but also by its distinctly and sharply toothed leaves which are rounded at the base.

## GUTTIFERAE

### CRATOXYLON Blume

**CRATOXYLON LIGUSTRINUM** (Spach) Blume Mus. Bot. Lugd.-Bat. 2 (1852) 16.

*Ancistrolobus ligustrinus* Spach Suit. Buff. 5 (1836) 358, Ann. Sci. Nat. II 5 (1836) 352, *t. 6.*

*Hypericum biflorum* Lam. Encycl. 4 (1797) 170.

*Hypericum chinense* Retz. Obs. 5 (1789) 27, non Linn.
*Hypericum olympicum* Lour. Fl. Cochinch. (1790) 471, non Linn.
*Hypericum petiolatum* Lour. op. cit. 472, non Linn.
*Elodes chinensis* Hance in Hook. Lond. Journ. Bot. 7 (1848) 472.
*Cratoxylon biflorum* Turcz. in Bull. Soc. Nat. Mosc. 36[1] (1863) 580.
?*Elodea pulchella* Hort. Chels. ex Loud. Hort. Brit. Suppl. 1 (1832) 587, *nomen nudum.*
*Ancistrolobus brevipes* Turcz. in Bull. Soc. Nat. Mosc. 31[1] (1852) 383.
*Cratoxylon polyanthum* Korth. Verh. Nat. Gesch. Bot. (1839–42) 175, *t. 36;* Gagnep. in Lecomte Fl. Gén. Indo-Chine 1 (1909) 290.
*Cratoxylon chinense* Merr. in Philip. Journ. Sci. 4 (1909) Bot. 292.

The earliest description of this species seems to be *Hypericum chinense* Retz. (1789), non Linn., this description being the basis of *Hypericum biflorum* Lam. (1797). *Cratoxylon biflorum* Turcz. is typified by *Wallich 4820,* this binomial being published without reference to Lamarck's earlier name (sub *Hypericum*), although representing the same species. The two forms described by Loureiro, one from Kwangtung Province, China, and one from Cochinchina, are both safely referable to the form currently known as *Cratoxylon polyanthum* Korth. The oldest specific name, regarding the validity of which there can be no question, appears to be *Cratoxylon ligustrinum* (Spach) Blume. *Elodea pulchella* Hort. Chels. ex Loud. Hort. Brit. Suppl. 1 (1832) 587, currently reduced here, is practically a *nomen nudum,* the whole description being the statement that it is an evergreen, herbaceous, ornamental plant with rosy flowers. The description of it as herbaceous would exclude this as a synonym of *Cratoxylon ligustrinum* Blume, and for that matter would exclude the species from the genus *Cratoxylon.*

## CALOPHYLLUM Linnaeus

### CALOPHYLLUM CUCULLATUM sp. nov.

Arbor parva, ramulis junioribus petiolisque ferrugineo-hirsutis, ramulis tenuibus, teretibus; foliis coriaceis, oblongis, 11 ad 20 cm longis, distincte acuminatis, basi late rotundatis et distincte cucullatis, petiolo 7 ad 10 mm longo; infructescentiis axillaribus, pedunculatis, circiter 5 cm longis, pedicellatis, plerumque 3 vel 4 flabellatim dispositis; fructibus ovoideis, laevis, 1 cm longis.

A small tree, the branchlets more or less ferruginous-hirsute as are the young petioles; the ultimate branches slender, terete, reddish-brown, 3 to 4 mm in diameter, the internodes up to 15 cm in length. Leaves oblong, coriaceous, smooth, shining, 11 to 20 cm long, 4.5 to 8 cm wide, the apex distinctly acuminate, the base broadly rounded and distinctly cucullate; midrib very prominent, the lateral nerves slender, very densely arranged; petioles 7 to 10 mm long. Infructescences axillary, peduncled, about 5 cm long, the peduncle 1 to 2 cm long, bearing usually 3 or 4 flabellately arranged pedicels, these up to 2 cm in length. Fruits ovoid, smooth, brown when dry, about 1 cm long.

MINDANAO, Surigao Province, *Bur. Sci. 34518 Ramos & Pascasio,* April 25, 1919, in thickets along streams at the iron deposit on the northeast coast.

Although the flowers of this species are as yet unknown, it seems to belong in the group with *Calophyllum soulattri* Burm. f. (*C. spectabile* Willd.); it is well characterized by its leaves being broadly rounded and conspicuously cucullate at the base.

CALOPHYLLUM OLIGANTHUM sp. nov. § *Apetalum.*

Arbor parva, glabra, ramulis tenuibus, teretibus; foliis oblongo-ellipticis ad oblongo-lanceolatis, coriaceis, 5 ad 10 cm longis, utrinque subaequaliter angustatis, basi cuneatis, apice distincte acuminatis; petiolo 8 ad 10 mm longo; inflorescentiis plerumque axillaribus, solitariis, pedunculatis, 2.5 ad 4 cm longis, floribus 3 ad 5, racemosis vel umbellatis; sepalis interioribus elliptico-obovatis, circiter 6 mm longis, exterioribus late ovatis, 4 mm longis, apice rotundatis et perspicue cucullatis; fructibus ellipsoideis, 1.5 cm longis.

A glabrous tree, 5 to 8 m high, the branches and branchlets slender, dark reddish-brown, terete, the internodes up to 5 cm in length. Leaves oblong, elliptic to oblong-lanceolate, coriaceous, shining, 5 to 10 cm long, 1.5 to 4 cm wide, subequally narrowed to the cuneate base and to the distinctly but blunt-acuminate apex; lateral nerves very slender, densely arranged; petioles 8 to 10 mm long. Inflorescences chiefly axillary, sometimes terminal, solitary, peduncled, 2.5 to 4 cm long, 3- to 5-flowered, the flowers either racemosely or umbellately arranged, their pedicels 1 to 1.5 cm long. Sepals white, the inner 2 elliptic-obovate, rounded, somewhat concave, about 6 mm long and 4 mm wide, the outer 2 broadly ovate, rounded, and conspicuously cucullate at their apices, about 4 mm long. Ovary globose, glabrous; style 3 mm long. Fruits dark brown when dry, nearly smooth, ellipsoid, 1.5 cm long.

BUCAS GRANDE, *Bur. Sci. 35110 Ramos & Pascasio* (type), June 10, 1919. MINDANAO, Surigao Province, *Bur. Sci. 34520 Ramos & Pascasio,* April 25, 1919. In forests at low altitudes, the branches pendulous.

This species very closely resembles *Calophyllum gracilipes* Merr. but the petals are lacking, and it further differs from this species in having the branches and branchlets terete instead of angled.

**CALOPHYLLUM BRACHYPHYLLUM** sp. nov.

Arbor parva, glaberrima, ramulis tenuibus, plus minusve angulatis; foliis crasse coriaceis, late ovatis ad elliptico-ovatis, 1.5 ad 2.5 cm longis, basi late rotundatis, apice rotundatis vel retusis; petiolo 1 ad 2 mm longo; fructibus globosis, laevis, 1.5 cm diametro.

A small glabrous tree, or the very tips of the branches obscurely puberulent, the branches grayish, the branchlets slender, usually somewhat angled, reddish-brown. Leaves thickly coriaceous, broadly ovate to elliptic-ovate, 1.5 to 2.5 cm long, 1.2 to 2 cm wide, the base broadly rounded, the apex rounded or often retuse; lateral nerves very slender and very densely arranged; petioles 1 to 2 mm long. Fruits globose, smooth, 1.5 cm in diameter, their peduncles usually solitary, 1 to 2 cm long.

MINDANAO, Surigao Province, *Bur. Sci. 34482 Ramos & Pascasio,* April 25, 1919, on the banks of Hegapit River at the iron deposit on the northeast coast, altitude about 350 meters.

A species manifestly allied to *Calophyllum pentapetalum* (Blanco) Merr. (*C. amplexicaule* Choisy), but its leaves are not cordate at the base and are distinctly petioled while the fruits are larger and perfectly globose.

## KAYEA Wallich

**KAYEA LANCEOLATA** sp. nov.

Arbor parva, glabra, ramis ramulisque teretibus; foliis coriaceis, lanceolatis, usque ad 23 cm longis, basi acutis vel obtusis, sursum sensim angustatis, tenuiter acute acuminatis, nitidis, nervis primariis utrinque 15 ad 20, tenuibus, quam secondariis vix magis distinctioribus; floribus terminalibus, sessilibus, dense fasciculatis, in siccitate nigris, sepalis obovatis, circiter 7 mm longis.

A small glabrous tree, the branches and branchlets yellowish, terete, smooth. Leaves lanceolate, coriaceous, rather pale and shining when dry, 18 to 23 cm long, 3 to 4 cm wide, base acute to obtuse, gradually narrowed upward from the lower one-fourth or one-third to the slenderly acuminate apex, the acumen acute or acuminate, subcaudate; primary lateral nerves 15 to 20 on each side of the midrib, scarcely more prominent than are the secondary nerves, both surfaces very shallowly foveolate by the rather close reticulations; petioles 1 to 1.5 cm long. Flowers white when fresh, black when dry, sessile, densely crowded in terminal fascicles 1 to 1.5 cm in diameter. Sepals obovate, about 7 mm long.

LUZON, Camarines Province, Paracale, *Bur. Sci. 33591 Ramos & Edaño,* November 28, 1918, in damp forests at low altitudes.

This species is readily distinguished by its lanceolate leaves, which are gradually narrowed upward to the slenderly subcaudate-acuminate apex, and by its terminal, crowded, sessile, fascicled flowers.

## FLACOURTIACEAE

### HYDNOCARPUS Gaertner

**HYDNOCARPUS HUTCHINSONII** sp. nov. § *Euhydnocarpus, Oliganthera.*

Arbor, usque ad 15 m alta, partibus junioribus floribusque exceptis glabra; foliis oblongis, coriaceis, 15 ad 25 cm longis, basi distincte inaequilateralibus, apice acuminatis, nervis utrinque 12 ad 14, perspicuis; floribus longe pedicellatis, 5-meris, sepalis pubescens, 9 ad 11 mm longis; petalis glabris, usque ad 13 mm longis, appendicibus linearis, usque ad 10 mm longis; staminibus 5; fructibus globosis, circiter 8 cm diametro, pericarpio fragile, seminibus usque ad 2 cm longis.

A tree, reaching a height of 15 m, glabrous except the younger parts and flowers. Leaves oblong, coriaceous or subcoriaceous, entire, 15 to 25 cm long, 5 to 9 cm wide, the base distinctly inequilateral, usually rounded or obtuse on the broader side and often acute on the narrower side, the apex rather abruptly and distinctly acuminate, the upper surface subolivaceous or brownish, shining, smooth, the lower surface brownish, distinctly reticulate; lateral nerves 12 to 14 on each side of the midrib, prominent, curved, anastomosing close to the margin; petioles usually about 1 cm long. Flowers yellow, the inflorescence axillary, few-flowered, the axils of the inflorescence up to 8 mm long, somewhat pubescent, usually simple; pedicels up to 2 cm long. Sepals 5, from 9 to 11 mm long, pubescent, reflexed in anthesis, oblong-elliptic to elliptic-ovate, rounded. Petals glabrous, up to 13 mm long, about 5 mm wide when spread, ultimately involute and inclosing a linear-oblong, flattened, free appendage up to 10 mm long and 1 mm wide, which is slightly pubescent above and attached by its base only. Stamens 5, the filaments 5 mm long, much thickened below, tapering upward, glabrous; anthers as long as the filaments. Rudimentary ovary pubescent. Fruit globose, about 8 cm in diameter, the pericarp rather thin when dry, brittle, externally puberulent. Seeds numerous, irregular, up to 2 cm in length.

MINDANAO, Zamboanga District, *For. Bur. 4822 Hutchinson,* *For. Bur. 9138, 9158, 9303, 9429* (type) *Whitford & Hutchinson:* Lanao District, *For. Bur. 23162, 23178 Agama;* Malangas, *Bur. Sci. 36938, 36943 Ramos & Edaño.* BASILAN, *For. Bur. 3435, 3916, 6116, Hutchinson, Bur. Sci. 15436 Reillo, 18959 Miranda.*

This species is common in primary forests in various parts of the Zamboanga District and in Basilan. Fruiting specimens have been collected in July, August, September, November, December, and January. Flowering specimens have been collected in December and February. What is apparently the same species is represented by *574 Agama,* from near Sandakan, British North Borneo. The local names recorded are *mangasalaokag* (Sul.), *bagarbas* (Lan.), and *kamupang* (Sul.).

## BEGONIACEAE

### BEGONIA Linnaeus

**BEGONIA DOLICHOTRICHA** sp. nov. § *Petermannia.*

Herba erecta, ramosa, saltem 50 cm alta, perspicue et patule ciliatis; foliis inaequilateralibus, chartaceis, oblongis ad oblongo-lanceolatis, 8 ad 13 cm longis, tenuiter acuminatis, basi lateraliter cordatis, margine irregulariter grosse dentatis, dentibus ciliatis, utrinque perspicue ciliatis; inflorescentiis circiter 5 cm longis, floribus ♂ paucis, sepalis 2, orbiculari-ovatis, circiter 1.5 cm longis, petalis, 0; capsulis solitariis, obovoideis, 2 cm longis et latis, truncatis, basi abrupte truncato-rotundatis, aequaliter 3-alatis, perspicue ciliatis.

An erect, branched herb, at least 50 cm high, the branches, petioles, leaves, and fruits conspicuously ciliate with long, slender, spreading, scattered, brownish hairs. Leaves thinly chartaceous, inequilateral, oblong to oblong-lanceolate, 8 to 13 cm long, 2.5 to 5 cm wide, the apex slenderly acuminate, the base laterally cordate, one side very broadly rounded, the other much narrower and acute or abruptly obtuse, the margins rather coarsely and irregularly toothed, the primary and secondary teeth terminated by rather long cilia, both surfaces with long, scattered, spreading hairs; petioles 7 to 15 mm long; stipules oblong-elliptic, up to 1.5 cm long, somewhat ciliate, terminated by a long, sparingly ciliate mucro, up to 5 mm in length. Inflorescences in the uppermost axils up to 5 cm long, somewhat peduncled, dichotomously branched, bearing near the base one or few female flowers, and above a few male ones, the bracts narrowly lanceolate, acuminate, 5 mm long or less. Staminate flowers white, the sepals 2, orbicular-ovate or somewhat reniform, rounded, up to 1.5 cm wide and nearly as long. Petals none. Stamens numerous, the anthers obovoid, about 1 mm long, shorter than the filaments. Capsules usually solitary, in outline obovoid, including the wings about 2 cm long and 2 cm wide at the truncate apex, somewhat narrowed below, the base abruptly truncate-rounded, the wings subequal, conspicuously ciliate with long, scattered, brownish hairs.

LUZON, Camarines Province, Mount Bagacay, *Bur. Sci. 33855, 33926* (type) *Ramos & Edaño,* December 18, 1918, on forested slopes, altitude about 650 meters, the leaves when fresh very red on the lower surface but merely brownish or brownish-red when dry.

This species is probably as closely allied to *Begonia macgregorii* Merr. as to any other described form. It is easily distinguishable by its numerous cilia and especially by its ciliate capsules.

**BEGONIA LONGIBRACTEA** sp. nov. § *Petermannia.*

Herba erecta, ramosa, saltem 40 cm alta, ramis perspicue subadpresse ciliatis; foliis membranaceis, inaequilateralibus, oblongo-obovatis, 6 ad 14 cm longis, profunde et irregulariter pinnatim lobatis, lobis usque ad 2.5 cm longis, plerumque grosse 1- vel 2-dentatis, apice tenuiter acuminatis, basi lateraliter cordatis; inflorescentiis axillaribus, solitariis, racemosis, circiter 1 cm longis, bracteis numerosis anguste lanceolatis leviter ciliatis, 8 ad 10 mm longis instructis; floribus ♂ paucis, sepalis 2, elliptico-ovatis, 5 mm longis, petalis 2, quam sepalis multo angustioribus; capsulis solitariis, 10 ad 12 mm longis, usque ad 15 mm latis, truncatis, basi late rotundatis, aequaliter 3-alatis, leviter ciliatis.

An erect, somewhat branched herb, at least 40 cm high, the lower nodes often rooting, the branches rather conspicuously subappressed-ciliate, the leaves slightly so. Leaves greenish when dry, membranaceous, in outline oblong-obovate, 6 to 14 cm long, 2 to 7 cm wide, conspicuously inequilateral, deeply and irregularly pinnately lobed, the lobes up to 2.5 cm long and often coarsely 1- or 2-toothed, the apex long and slenderly acuminate, the acumen toothed, the base somewhat narrowed, laterally cordate, one side rounded, the other usually acute, the upper surface with few, scattered, elongated hairs, the lower somewhat appressed-hirsute on the midrib and veins; petioles 5 mm long or less; stipules narrowly lanceolate, acuminate, about 8 mm long, sparingly ciliate. Inflorescences axillary, of short, few-flowered, simple racemes, the axils, 1 cm long or less, supplied with numerous, narrowly lanceolate, long, acuminate, somewhat ciliate bracts, 8 to 10 mm in length and about 1.5 mm wide. Male flowers pinkish-white, their pedicels up to 10 mm in length. Sepals 2, elliptic-ovate, slightly ciliate, about 5 mm long. Petals 2, narrowly elliptic-oblong, about 3.5 mm long, 1.5 mm wide. Capsules solitary, axillary, including the wings 10 to 12 mm long and 12 to 15 mm wide, the apex truncate, the outer angles acute, slightly narrowed below to the rather broadly rounded base, sparingly ciliate.

SIARGAO, *Bur. Sci. 34870 Ramos & Pascasio*, May 27, 1919, among bowlders on forested slopes at low altitudes.

A species similar and distinctly allied to *Begonia urdanetensis* Elm. but with larger leaves, quite different indumentum, and narrower stipules.

## THYMELAEACEAE

### GYRINOPSIS Decaisne

**GYRINOPSIS ACUMINATA** sp. nov.

Frutex, floribus exceptis glaber, foliis anguste lanceolatis ad lanceolatis, 12 ad 20 cm longis, tenuiter acuminatis, basi cuneatis, nervis numerosis, dense dispositis; floribus axillaribus, fasciculatis, leviter pubescens, circiter 5 mm longis; capsulis circiter 1 cm longis, rugosis, obovoideis.

A shrub or small tree, entirely glabrous except the flowers, the branchlets usually reddish-brown. Leaves narrowly lanceolate to lanceolate, 12 to 20 cm long, 2.5 to 4.5 cm wide, narrowed to the cuneate base and to the slenderly acuminate apex, greenish or olivaceous and shining when dry. The primary lateral nerves scarcely distinguishable from the densely arranged secondary ones; petioles 5 mm long or less. Flowers axillary, fascicled or in very greatly reduced cymes, their pedicels about 2.5 mm long. Perianth slightly pubescent, about 5 mm long, the lobes 5, oblong, obtuse, about 1.5 mm long. Stamens 10 in a single row near the throat, 5 alternating anthers slightly longer than the others. Ovary oblong-ovoid, narrowed upward, pubescent; style very short. Capsules yellowish, rugose when dry, 1 cm long or less, 2-valved, usually containing a single, subglobose, black seed, 5 to 6 mm in diameter.

DINAGAT, *Bur. Sci. 35158 Ramos & Pascasio* (type), May 13, 1919. BUCAS GRANDE, *Bur. Sci. 35055 Ramos & Pascasio*, June 11, 1919, in forests at low altitudes.

This species is closely allied to *Gyrinopsis brachyantha* Merr., from which it is distinguished by its longer, slenderly acuminate, differently shaped leaves.

## COMBRETACEAE

### TERMINALIA Linnaeus

**TERMINALIA SURIGAENSIS** sp. nov. § *Diptera.*

Arbor parva, glabra, ramulis incrassatis, 1 ad 1.5 cm diametro, cicatricibus multis instructis; foliis numerosis, confertis, coriaceis, anguste oblongo-obovatis ad oblanceolatis, 10 ad 14 cm longis, basi cuneatis, apice obtusis ad rotundatis, nervis utrinque circiter 10, tenuibus; inflorescentiis simplicibus, 7 ad 13 cm longis; fructibus 2-alatis, late ellipticis, 1.5 ad 1.8 cm longis et latis, apice retusis apiculatisque.

A glabrous tree, about 6 m high, the ultimate branchlets thickened, 1 to 1.5 cm in diameter, marked with numerous crowded scars of fallen leaves. Leaves densely crowded at the tips of the branchlets, narrowly oblong-obovate to oblanceolate, 10 to 14 cm long, 2 to 5 cm wide, coriaceous, shining, yellowish-green or brownish when dry, gradually narrowed to the cuneate base, the apex obtuse to rounded; lateral nerves about 10 on each side of the midrib, slender; petioles 1 to 1.5 cm long, usually with 2 rather conspicuous glands. Inflorescences axillary, simple, 7 to 13 cm long. Flowers reddish. Calyx funnel-shaped, glabrous, about 5 mm long, the teeth 5, triangular, acute. Fruits 2-winged, including the wings broadly elliptic, 1.5 to 1.8 cm long and nearly as wide, the apex retuse and reticulate, base rounded, the seed-bearing portion of the fruit plane on one side and somewhat keeled on the other, the wings coriaceous.

MINDANAO, Surigao Province, *Bur. Sci. 34711* (type), *34600, Ramos & Pascasio,* April 25 and June 15, 1919, along streams at low altitudes ascending to 350 meters.

A species very similar in appearance and very closely allied to *Terminalia darlingii* Merr., from which it is distinguished by its smaller leaves and fruits.

## MELASTOMATACEAE

### MEDINILLA Gaudichaud

**MEDINILLA CAPITATA** sp. nov.

Frutex epiphyticus, scandens, ramis ramulisque teretibus, partibus junioribus stellato-pubescens; foliis oppositis, subsessilibus, penninerviis, obovato-ellipticis, usque ad 13 cm longis, acuminatis, basi rotundatis vel obscure cordatis, nervis utrinque 3; inflorescentiis lateralibus, solitariis, 2 ad 2.5 cm longis, subglobosis ad ovoideis, densis; floribus 5-meris, racemosis; bracteis ovatis-obovatis ad spatulatis, 10 ad 13 mm longis.

A slender, epiphytic, scandent shrub, the stems frequently emitting roots, the branches and branchlets terete, the latter, and the petioles and leaves on the midrib beneath, distinctly stellate-pubescent with short brown hairs. Leaves opposite, penninerved, obovate-elliptic, subsessile, 10 to 13 cm long, 5 to 9 cm wide, the apex shortly acuminate, the base somewhat narrowed, rounded or obscurely cordate; midrib prominent, the lateral nerves leaving it in the lower 2 to 4 cm, distinct, ascending, usually 3 on each side of the midrib, the inner pairs extending to the apex; petioles 2 mm long or less. Inflorescences lateral, solitary, subsessile, the flowers densely arranged in simple, globose to ovoid racemes, 2 to 2.5 cm long, each flower subtended by an obovate to spatulate, red, slightly pubescent bracteole, 10 to 13 mm in length. Pedicels short. Calyx urceolate, about 7 mm long and 5 mm in diameter, slightly stellate-pubescent, the limb produced, obscurely 5-toothed. Ovary 5-celled.

DINAGAT, *Bur. Sci. 35179, Ramos & Pascasio,* May 11, 1919, on tree trunks in forests at low altitudes.

A remarkably characteristic species not closely allied to any previously described form, distinguishable by its subsessile, penninerved, opposite leaves; its stellate, brownish, rather sparse indumentum; and its dense, lateral, subcapitate, simple racemes of 5-merous flowers.

**MEDINILLA CONFERTIFLORA** sp. nov.

Frutex erectus, glaberrimus, ramulis teretibus, foliis oppositis, sessilibus, oblongo-obovatis ad oblongo-lanceolatis, usque ad 20 cm longis, tenuiter acuminatis, basi perspicue angustatis, penninerviis, nervis utrinque 4; inflorescentiis caulinis, ramosis, circiter 7 cm longis, densissime multifloris et multibracteatis, bracteis angustis obovatis ad spatulatis usque ad 15 mm longis; floribus 4-meris.

An erect, entirely glabrous shrub, about 3 m high, with terete stems and opposite, sessile leaves. Leaves chartaceous when dry, oblong-obovate to oblong-lanceolate, 14 to 20 cm long, 5 to 10 cm wide, olivaceous, penninerved, the apex slenderly acuminate, narrowed below to the rounded base, the narrow basal portion of the leaf 2 to 5 cm in length and 1.5 to 3 cm in width; lateral nerves usually 4 on each side of the midrib, leaving it in the lower half, ascending, the inner two pairs reaching the apex or nearly so, the transverse reticulations distant, parallel, prominent. Inflorescences from the trunks, woody, branched, about 7 cm long, densely many-flowered and multibracteate, the bracts narrowly obovate to spatulate, glabrous, up to 15 mm long, the younger ones red when dry, the older ones greenish. Flowers 4-merous, their pedicels up to 6 mm long. Calyx urceolate, up to 6 mm long, the limb much produced and about 3 mm long, obscurely 4-toothed, the teeth broad, nerved. Stamens 8, equal. Ovary 4-celled.

PANAY, Capiz Province, Libacao, *Bur. Sci. 35413 Martelino & Edaño,* June 3, 1919, on forested slopes at low altitudes.

This species belongs in the group with *Medinilla trunciflora* Merr. and *M. aurantiaca* Elm., but differs from both in being entirely glabrous.

**MEDINILLA FERRUGINEA** sp. nov.

Frutex scandens, partibus junioribus dense ferrugineo-villosis, ramulis teretibus, foliis oppositis, in paribus valde inaequalibus; foliis majoribus, lanceolatis ad oblongo-lanceolatis, penninerviis, acuminatis, basi angustatis, acutis, usque ad 20 cm longis, nervis utrinque 3, perspicuis, breviter petiolatis; foliis minoribus late ovatis, acuminatis, basi profunde cordatis, sessilibus, 1 ad 2 cm longis; inflorescentiis lateralibus, solitariis vel fasciculatis, racemosis, 2 ad 3 cm longis, bracteis numerosis, ovatis ad oblongo-ovatis, villosis, 10 ad 12 mm longis; floribus 4-meris.

A scandent shrub, with terete branches and branchlets, and opposite, very unequal leaves, the smaller leaves of each pair often deciduous on the older stems, the branchlets, petioles, inflorescences, and the younger leaves rather densely ferruginous-pilose with long, weak, spreading hairs. Leaves chartaceous, the larger ones of each pair lanceolate to oblong-lanceolate, penninerved, slenderly acuminate, narrowed below to the obtuse or acute base, 14 to 20 cm long, 3 to 6 cm wide, the lateral nerves usually 3 on each side of the midrib and leaving it in the lower 2 to 4 cm, sharply ascending, prominent, the transverse reticulations distinct; petioles 7 mm long or less. Smaller leaves of each pair broadly ovate, acuminate, deeply cordate at the base, the sinus narrow, the lobes broadly rounded, of the same texture and with the same type of indumentum as the larger leaves, 1 to 2 cm long, sessile. Inflorescences chiefly from the branches below the leaves, solitary or fascicled, consisting of short, chiefly simple racemes, 2 to 3 cm in length, supplied with numerous, ovate to oblong-ovate, acute or acuminate, villous, 10 to 12 mm long bracts, two bracts subtending each flower. Calyx villous, ovoid, the limb slightly produced, obscurely and shallowly 4-toothed. Stamens 8, apparently equal. Ovary 4-celled.

DINAGAT, Bucas Grande, *Bur. Sci. 35217* (type), *35048, 35223*

*Ramos & Pascasio*, May and June, 1919, in forests at low altitudes.

A species remarkable for its ferruginous indumentum and its very unequal leaves, the opposite one of each pair being reduced to a broadly obovate, acuminate, deeply cordate, sessile one, entirely different in shape and size from the other of the same pair.

MEDINILLA PURPUREA Elm. in herb. sp. nov.

Frutex scandens, nodis densissime longeque setosis exceptis glaberrimus, ramis teretibus; foliis oppositis, coriaceis, valde inaequalibus, majoribus oblongo-ovatis ad oblongo-ellipticis, petiolatis, usque ad 25 cm longis et 12 cm latis, basi cordatis vel rotundatis, perspicue 7-plinerviis, apice perspicue acuminatis, nervis transversalibus obsoletis, minoribus ovatis, sessilibus, 2 ad 3 cm longis, vel obsoletis. Inflorescentiis axillaribus, longe pedunculatis, capitatis, 4 ad 5 cm diametro, pedunculo usque ad 2 cm longo, bracteis numerosissimis, obovatis, usque ad 1.5 cm longis; floribus 4-meris.

A scandent shrub, entirely glabrous except the densely long-setose nodes, the branches terete, the numerous, rather soft setae at the nodes 1 to 3 cm in length. Leaves opposite, in very unequal pairs, or the smaller one of each pair sometimes obsolete; larger leaves coriaceous, oblong-ovate to oblong-elliptic, pale or somewhat olivaceous when dry, shining, 22 to 26 cm long, 8 to 12 cm wide, the base more or less cordate, sometimes rounded, prominently 7-plinerved, the inner two pairs of nerves reaching the apex, the transverse nerves and reticulations obsolete, the apex rather abruptly and prominently acuminate, the acumen slender, blunt, up to 1.5 cm long; petioles 1 to 1.5 cm long; smaller leaves of each pair same in texture as the larger ones, ovate, sessile, 2 to 3 cm long, 1 to 2 cm wide, frequently wanting. Inflorescences axillary, solitary, long-peduncled, the flowers crowded in dense, globose to ovoid heads at the ends of the peduncles, the latter 12 to 20 cm long, the heads 4 to 5 cm in diameter. Flowers 4-merous, their pedicels up to 4 mm long, the bracts very numerous, obovate, often retuse, red or purple, up to 15 mm long and 10 mm wide. Calyx truncate. Petals 4, obovate, at least 1 cm long. Stamens 8, unequal, the anthers lanceolate-acuminate, 6 mm long, the appendages and spur short. Fruit ovoid, up to 1.5 cm long.

LUZON, Sorsogon Province, Mount Kililibong, *Bur. Sci. 23701 Ramos* (type), August, 1919: Tayabas Province, Mount Cadig, *Bur. Sci. 25461 Yates*, December 12, 1916. CATANDUANES, Mount Mariguidon, *Bur. Sci. 30526 Ramos,* November, 1917. On trees in the mossy forests at and above an altitude of 700 meters.

A remarkable species, entirely different from all other known representatives of the genus, strongly characterized by its densely long-setose nodes; its remarkably unequal leaves, the smaller leaf of each pair being very greatly reduced or even obsolete; and by its long-peduncled, capitate, densely bracteate inflorescences. The name *Medinilla purpurea* was applied by Mr. Elmer to *23701 Ramos* with reference to material collected by him in Sorsogon that represented the same species. Unfortunately Mr. Elmer's material was lost and, as the duplicates of the specimen cited above have been distributed under his manuscript name, the description is accordingly published here.

**MEDINILLA UMBELLATA** sp. nov.

Frutex scandens, partibus junioribus minute castaneo-furfuraceis, ramulis teretibus, foliis verticillatis, sessilibus, obovatis, usque ad 23 cm longis, apice abrupte breviter acuminatis, basi angustatis, penninerviis, nervis utrinque 3, valde perspicuis; inflorescentiis lateralibus, umbellatis, pedunculatis, pedunculato 5 cm longo; floribus circiter 15, pedicellatis, 5-meris, bracteis anguste oblanceolatis, circiter 1 cm longis.

A scandent shrub with terete branchlets, verticillate, obovate, penninerved, sessile leaves, and lateral, simple, peduncled, umbellate inflorescences, the indumentum, chiefly confined to the inflorescences and the younger parts, consisting of very short, dark-brown, furfuraceous hairs. Leaves usually 4 at each node, sessile, obovate, 20 to 23 cm long, 12 to 14 cm wide, chartaceous to subcoriaceous, the upper surface olivaceous, the lower usually brownish, abruptly and shortly acuminate, narrowed below to the obtuse base, the narrow basal portion up to 5 cm long, at the very base not exceeding 1 cm in width, penninerved, the lateral nerves usually 3, leaving the midrib in the lower half, ascending, curved, the inner 2 pairs reaching the apex, the transverse reticulations distant, very prominent, the upper surface glabrous, the midrib on the lower surface very sparingly brown-furfuraceous. Inflorescences from leafless nodes, apparently solitary, simple, umbellate, their peduncles about 5 cm long, each bearing 15 or fewer flowers, the subtending bracts narrowly oblanceolate, about 1 cm long, the pedicels about 5 mm long, all parts distinctly but minutely furfuraceous-pubescent with dark-brown hairs. Buds ellipsoid, about 7 mm long; calyx obscurely 5-toothed.

MINDANAO, Surigao Province, *Bur. Sci. 34744* (type), *34773 Ramos & Pascasio,* June 20, 1919, along streams in forests at low altitudes.

This characteristic species is as closely allied to *Medinilla furfuracea* Merr. as to any other described form, but differs radically in its sessile, entirely differently shaped leaves, and different inflorescences.

## ARALIACEAE

### ANOMPANAX Harms

**ANOMPANAX PHILIPPINENSIS** Harms in Ann. Jard. Bot. Buitenz. **19** (1904) 15.

*Pentapanax* sp. Ceron Cat. Pl. Herb. Manila (1892) 89.

The type of this species is *Warburg 14470,* from Davao, Mindanao, and it is by no means certain that the species is really different from the type of the genus, *Anompanax celebicus* Harms. Regarding the latter, I examined Koorders's Celebes material in the Buitenzorg herbarium in January, 1914, noting that the Celebes material looks exactly like the Philippine specimens and that the two species were either identical or very closely allied. *Anompanax philippinensis* is now known from a number of localities in the central and southern Philippines, as follows: SAMAR, *Bur. Sci. 17454 Ramos.* NEGROS, *For. Bur. 17355 Curran, 7269, 12329 Everett, Merrill 7034.* PANAY, *Vidal 2930* in Herb. Kew., *Yoder, Bur. Sci. 30798 Ramos & Edaño, 32354 McGregor.* MINDANAO, *Merrill 8293, Clemens 1058, For. Bur. 4686 Mearns & Hutchinson.* BASILAN, *For. Bur. 18936 Miranda.* A species widely scattered on damp forested slopes at medium altitudes.

**ANOMPANAX CUMINGIANUS** (Presl) comb. nov.

*Paratropia cumingiana* Presl Epim. (1851) 250; Walp. Ann. 2 (1852) 725.
*Panax cumingiana* Rolfe in Journ. Linn. Soc. Bot. 21 (1884) 310.
*Polyscias cumingiana* F.-Vill. Novis. App. (1880) 102.
*Nothopanax cumingii* Seem. in Journ. Bot. 4 (1866) 295.

MINDORO, *Cuming 1553.*

Seemann, l. c., records this species also from Borneo, but I have seen no material representing it other than Cuming's collection, the type of the species. My specimen is incomplete, but the ovary is always 2-celled and, although the calyx is truncate, not at all toothed or lobed, I feel confident that *Anompanax* is its correct generic position. It certainly cannot properly be placed in any of the other genera to which it has been assigned by various botanists.

**ANOMPANAX DIGITATUS** sp. nov.

Frutex erectus, parvus, glaber; foliis longipetiolatis, digitatim 5-foliolatis, foliolis exterioribus subsessilibus, interioribus longipetiolulatis, membranaceis, oblongo-ovatis ad oblongo-ellipticis, acutis vel acuminatis, 12 ad 24 cm longis, nervis utrinque 6 ad 12; inflorescentiis brevibus, circiter 10 cm longis, ramis primariis 2 vel 3, ramis secondariis umbellatim dispositis; calycis ovoideis, circiter 5 mm longis, 5-dentatis, dentibus acutis, 1 mm longis.

An erect, slender shrub, the ultimate branches about 5 mm in diameter. Leaves long-petioled, digitately 5-foliolate, the outer two leaflets sessile or nearly so, the inner three with petiolules 3 to 5 cm in length; petioles 12 to 15 cm long, inflated and clasping at the base; leaflets membranaceous or thinly chartaceous, shining, oblong-ovate to oblong-elliptic, 12 to 24 cm long, 5 to 10 cm wide, the apex acute or obscurely but sharply acuminate, the base often somewhat inequilateral, acute or acuminate; lateral nerves slender, 6 to 12 on each side of the midrib. Inflorescences short, about 10 cm long, the peduncle about 1 cm in length with 2 or 3 primary branches, these bearing from 4 to 7 secondary, umbellately arranged, 1 to 2 cm long branchlets; the flowers subumbellately or racemosely arranged toward the tips of the branchlets, their pedicels about 5 mm long, jointed. Calyx after flowering ovoid, about 5 mm long, 5-toothed, the teeth oblong-ovate, acute, 1 mm long. Ovary 2-celled; styles 2, stout, somewhat recurved, about 1.5 mm long.

SIARGAO, *Bur. Sci. 34925 Ramos & Pascasio,* June 2, 1919, in forests at low altitudes, the height indicated as 0.5 meter.

This species differs from *Anompanax philippinensis* Harms in its smaller size, its strictly digitate leaves, fewer leaflets, and in its short, comparatively simple inflorescences.

### BOERLAGIODENDRON Harms

**BOERLAGIODENDRON DINAGATENSE** sp. nov.

Frutex glaber, circiter 2 m altus, ramulis ultimis circiter 5 mm diametro; foliis oblongis ad oblongo-ellipticis, coriaceis, 14 ad 18 cm longis, basi acutis vel obtusis, apice plerumque acutis, marginae leviter undulatis et minute denticulatis, penninerviis, nervis utrinque circiter 12, tenuibus, petiolo 2 ad 2.5 cm longo; inflorescentiis circiter 7 cm diametro, breviter pedunculatis, ramis primariis circiter 15, umbellatim dispositis, ramis secondariis circiter 2 cm longis, fructibus umbellatim dispositis, ovoideis, circiter 5 mm longis.

A glabrous shrub, about 2 m high, the ultimate branchlets about 5 mm in diameter. Leaves coriaceous, oblong to oblong-elliptic, 14 to 18 cm long, 5 to 7 cm wide, somewhat narrowed below to the acute or obtuse base, the apex usually acute, margins somewhat undulate and minutely toothed in the sinuses of the undulations; lateral nerves slender, pinnately arranged, about 12 on each side of the midrib, not very prominent; petioles 2 to 2.5 cm long, their bases with a single, obscure, unarmed crest. Inflorescences terminal, about 7 cm in diameter, the peduncle rather slender, about 2 cm long; primary branches about 15, umbellately arranged, these bearing 2 lateral branches and a central, nearly sessile, or short-peduncled umbel of sterile flowers, the lateral branches jointed at about the middle and bearing 2 small bracts. Fruits umbellately arranged at the tips of the lateral branchlets, ovoid, about 5 mm long, their pedicels 2 to 3 mm in length; seeds usually 3.

DINAGAT, *Bur. Sci. 35220 Ramos & Pascasio,* May 12, 1919, in forests at low altitudes.

This species is distinctly an ally of *Boerlagiodendron simplicifolium* Elm. and, like it, is characterized by its oblong, entire, pinnately nerved leaves; among other characters it differs radically from the latter species in its much shorter petioles.

## MYRSINACEAE

### DISCOCALYX Mez

**DISCOCALYX LONGISSIMA** sp. nov.

Frutex glaber, circiter 1 m altus; foliis numerosis, linearis, integris, 18 ad 25 cm longis, 7 ad 14 mm latis, utrinque angustatis, acuminatis, subtus glandulosis, breviter petiolatis; racemis brevibus, tenuibus, paucifloris, 1 ad 1.5 cm longis, in ramulis axillaribus tenuibus dispositis, ramulis specialibus 12 ad 16 cm longis, foliis paucis valde reductis instructis, partibus apicalibus cicatricibus bracteisque multis instructis; floribus minutus, 5-meris, sepalis perspicue glandulosis.

A glabrous shrub, about 1 m high, the branches smooth, terete, brownish, the ultimate ones about 1 mm thick. Leaves numerous, linear, entire, 18 to 25 cm long, 7 to 14 mm wide, narrowed to the acuminate apex, the base much narrowed and abruptly acute or obtuse, olivaceous and shining when dry, distinctly glandular-punctate beneath, the midrib very prominent, the reticulations rather close, distinct; petioles stout, 3 mm long or less. The specialized slender branches bearing the inflorescences axillary, solitary, 12 to 16 cm long, each supplied with

2 or 3 greatly reduced, narrowly lanceolate leaves about 1.5 cm in length, the apical 1 to 2 cm slightly thickened, about 1.5 mm in diameter, these thickened parts supplied with many narrowly lanceolate, acuminate bracts 5 to 10 mm in length and marked with numerous scars of fallen bracts, this thickened portion bearing 1 or 2 slender, few-flowered racemes 1 to 1.5 cm long. Flowers 5-merous, reddish; the sepals narrowly oblong, about 1 mm long, with few, large, prominent glands.

MINDANAO, Surigao Province, *Bur. Sci. 34456 Ramos & Pascasio,* April 14, 1919, on rocky forested slopes at low altitudes.

This species is similar and manifestly closely allied to *Discocalyx angustissima* Merr., from which it is distinguished by its entire leaves.

## EBENACEAE

### DIOSPYROS Linnaeus

**DIOSPYROS LONGICILIATA** sp. nov.

Frutex parvus, ramulis et petiolis et foliis perspicue longe ciliatis, ramis ramulisque tenuibus; foliis chartaceis, oblongo-lanceolatis, 9 ad 16 cm longis, basi rotundatis, apice tenuiter acute acuminatis, nervis utrinque circiter 12; floribus longe ciliatis, axillaribus, solitariis, sessilibus, calycis tubo brevissimo, lobis lanceolatis, acuminatis, circiter 4 mm longis; ovario densissime ciliato.

A small shrub, the branchlets, petioles and portions of the leaves prominently ciliate with long, slender, spreading hairs, these hairs usually about 2 to 3 mm in length. Branches slender, erect, glabrous, black when dry. Leaves oblong-lanceolate, chartaceous, 9 to 16 cm long, 2 to 3.5 cm wide, brownish-olivaceous when dry, base rounded, apex rather slenderly and sharply acuminate, both surfaces and the margins long-ciliate with scattered hairs, these more numerous on the midrib than on other parts of the leaf; lateral nerves slender, about 12 on each side of the midrib, anastomosing, the reticulations lax, distinct; petioles about 3 mm long. Pistillate flowers solitary, axillary, sessile, 4-merous. Calyx-tube very short, the lobes lanceolate, prominently long-acuminate from a broad base, about 4 mm long, conspicuously long-ciliate. Corolla reddish, the tube about 5 mm long, externally long-ciliate, the lobes oblong, about 6 mm in length. Staminodes 4. Ovary very densely ciliate with long ascending hairs up to 4 mm in length; style densely hirsute below.

DINAGAT, *Bur. Sci. 35189, Ramos & Pascasio,* May 11, 1919, in forests at low altitudes.

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A species, prominently characterized by its numerous, long, spreading hairs, closely allied to *Diospyros everettii* Merr., one that has the same type of indumentum. The present species differs from the latter in its much thinner, more-numerously nerved leaves and in the much more conspicuous and denser indumentum which is found on the branchlets, petioles, both surfaces of the leaves, and the flowers, while in *D. everettii* the hairs are few in number and are practically confined to the branchlets and flowers.

## LOGANIACEAE

### GENIOSTOMA Forster

**GENIOSTOMA LANCILIMBUM** sp. nov.

Arbor parva, glabra, ramis teretibus, tenuibus; foliis lanceolatis ad oblongo-lanceolatis, 7 ad 10 cm longis, utrinque angustatis, basi acutis, apice caudato-acuminatis, chartaceis, nervis utrinque circiter 7, reticulis subobsoletis; floribus axillaribus, solitariis, pedicellatis; fructibus subglobosis, 6 ad 8 mm diametro.

A glabrous shrub or small tree, 3 to 4 m high, the branches and branchlets terete, slender, the former grayish, the latter often black when dry. Leaves lanceolate to oblong-lanceolate, 7 to 10 cm long, 1.5 to 3 cm wide, narrowed below to the acute base and above to the slender, caudate-acuminate apex, chartaceous, shining, olivaceous or black when dry, the midrib distinct; lateral nerves slender, indistinct, usually about 7 on each side of the midrib, obscurely anastomosing, the reticulations obsolete or nearly so; petioles 3 to 6 cm long. Flowers white, axillary, solitary, their pedicels about 5 mm long. Calyx 2.5 to 3 mm in diameter, the lobes 5, glabrous, broadly triangular-ovate, acute, about 1 mm long, their margins very obscurely ciliate. Corolla-tube 3 mm long, the lobes reflexed, oblong-ovate, 2 mm long, the throat densely villous inside. Fruits subglobose, black when dry, 6 to 8 mm in diameter.

PANAY, Capiz Province, Libacao, *Bur. Sci. 35332* (type), *35344 Martelino & Edaño,* May 28, 1919, in open forests at low altitudes.

In its axillary, solitary flowers this species is apparently allied to *Geniostoma longipes* Merr., but is radically different from that species in its vegetative and other characters.

**GENIOSTOMA RAMOSII** sp. nov.

Frutex erectus, 3 m altus, inflorescentiis exceptis glaber; foliis membranaceis, oblongo-ellipticis, 10 ad 13 cm longis, breviter acuminatis, basi rotundatis et leviter decurrentibus, nervis utrinque circiter 8, tenuibus, distinctis; floribus fasciculatis, pedicellatis, calycis lobis triangulari-ovatis, acutis, 2 mm longis; fructibus subglobosis, circiter 5 mm diametro.

An erect shrub, about 3 m high, glabrous except the inflorescences, the branches and branchlets terete, pale. Leaves membranaceous, oblong-elliptic, nearly black when dry, 10 to 13 cm long, 4 to 6.5 cm wide, the base rounded to subacute or somewhat decurrent, the apex shortly but distinctly acuminate; lateral nerves slender, distinct, anastomosing, about 8 on each side of the midrib, the reticulations lax, not prominent; petioles 1 cm long. Flowers axillary, fascicled, their pedicels somewhat pubescent, about 7 mm long. Calyx about 5 mm long, the lobes pubescent, triangular-ovate, acute, 2 mm in length. Fruits 4 to 10 in each fascicle, subglobose, black when dry, about 5 mm in diameter, when young somewhat pubescent, ultimately glabrous, their pedicels up to 8 mm in length.

SIARGAO, *Bur. Sci. 34893 Ramos & Pascasio*, May 29, 1919, in forests at low altitudes.

A species closely allied to *Geniostoma nigrescens* (Blanco) Merr. but with the exception of the inflorescences entirely glabrous and with larger leaves.

## APOCYNACEAE

### ALYXIA Banks

**ALYXIA STENOPHYLLA** sp. nov.

Frutex scandens, glabra, ramis ramulisque teretibus, tenuibus, ultimis 1 ad 1.5 mm diametro; foliis plerumque verticillatis, 4 ad 6 cm longis, 6 ad 10 mm latis, anguste lanceolatis, utrinque subaequaliter angustatis, basi acutis, apice obtuse acuminatis, chartaceis vel subcoriaceis, nervis lateralibus obsoletis; inflorescentiis axillaribus, solitariis, pedunculatis, umbellatim 3- vel 4-floris, pedunculo 1 ad 1.5 cm longo. Corollae tubo 7 mm longo.

A glabrous vine, the branchlets slender, terete, the ultimate ones 1 to 1.5 mm in diameter. Leaves mostly verticillate, sometimes opposite, narrowly lanceolate, 4 to 6 cm long, 6 to 10 mm wide, subequally narrowed to the acute base and the blunt-acuminate apex, firmly chartaceous or subcoriaceous, shining when dry, the margins slightly recurved; midrib prominent, the lateral nerves and reticulations obsolete; petioles 2 to 3 mm long. Inflorescences axillary, solitary, umbellately 3- or 4-flowered, the peduncles 1 to 1.5 cm long, the pedicels about 3 mm long, 2-bracteolate at their apices, the bracteoles lanceolate, acuminate, 1 mm long. Calyx about 3 mm long, the lobes lanceolate-acuminate. Corolla-tube about 7 mm long, white.

PANAY, Capiz Province, Mount Salibongbong, *Bur. Sci. 35574 Martelino & Edaño,* June 19, 1919. In thickets and forests near the summit, altitude about 650 meters.

This species resembles *Alyxia blancoi* Merr. but is easily distinguished by its longer peduncles and by its terete, not 4-angled, branchlets; it differs from *Alyxia lanceolata* Merr. in its glabrous inflorescences.

ALYXIA OBOVATIFOLIA sp. nov.

Frutex scandens, partibus junioribus pubescens, ramulis acute 4-angulatis; foliis verticillatis, crasse coriaceis, obovatis ad oblongo-obovatis, 4 ad 6 cm longis, apice late rotundatis, deorsum angustatis, basi cuneatis, margine valde recurvatis, nervis lateralibus obsoletis; floribus axillaribus, sessilibus vel subsessilibus, plerumque binis, calycis pubescens, corollae tubo circiter 1 cm longo.

A scandent vine, the branchlets sharply 4-angled, the internodes 2 to 4 cm long, the younger parts somewhat pubescent. Leaves verticillate, usually 4 at each node, thickly coriaceous, obovate to oblong-obovate, shining, 4 to 6 cm long, 1.5 to 2.5 cm wide, the apex broadly rounded and sometimes slightly retuse, narrowed below to the cuneate base, the margins strongly recurved, the midrib prominent, the lateral nerves obsolete, the mature leaves glabrous, the very young ones somewhat pubescent; petioles about 5 to 7 mm long. Flowers white, axillary, usually in pairs, sessile or subsessile, the calyx pubescent, the lobes lanceolate, acuminate, about 1.5 mm long. Corolla-tube glabrous, about 1 cm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34492 Ramos & Pascasio,* April 25, 1919, in rather dry thickets along small streams at low altitudes at the iron deposit on the northeast coast.

A species strongly characterized by its thickly coriaceous, obovate to oblong-obovate, rounded, nerveless leaves, and its very short, axillary, usually 2-flowered inflorescences. It is not closely allied to any previously described form.

KIBATALIA G. Don

(*Kickxia* Blume, non Dumortier)

In 1827 Dumortier published the generic name *Kickxia* for a small group of scrophulariaceous plants which some subsequent botanists have placed in *Linaria.* This disposition of Dumortier's genus is by no means universally accepted and some European and American botanists maintain *Kickxia* Dum. as a valid genus in spite of the fact that all current botanical works of a general nature and those on the African and Indo-Malayan floras maintain *Kickxia* Blume for a genus of apocynaceous plants. Under the circumstances it would seem that *Kickxia* Blume must be abandoned, as its use is distinctly invalidated by Dumortier's previous use of the same name for a different genus of plants.

The genus under discussion was originally described in 1826 as *Hasseltia* Blume, this name being invalidated by the earlier *Hasseltia* HBK. The first description of the genus under the name *Kickxia* was published in 1848,[2] but as early as 1828 Blume had realized the necessity of a new name for his *Hasseltia* and proposed[3] to subsitute the name *Kickxia* which, however, due to a typographical error appears as *Kixia;* as Blume himself in later publishing a description and figure of this genus altered the name to *Kickxia* and, further, as the genus was dedicated to Prof. Jean Kickx no other explanation of *Kixia* is possible and accordingly this form has no valid standing.

No new name is necessary for this apocynaceous genus in view of the fact that G. Don[4] has proposed the generic designation *Kibatalia* for *Hasseltia* Blume, non HBK. So long as individual botanists differ in their conception as to what constitutes and what does not constitute a genus cases of nomenclature like this will occur; and unless Blume's generic name be definitely abandoned we have here a case where *Kickxia* Blume will be recognized by those botanists who do not recognize *Kickxia* Dum. as distinct from *Linaria,* while those who recognize Dumortier's genus as a valid one cannot recognize *Kickxia* Blume as a generic designation. The logical course to follow in this case seems to be to abandon Blume's generic name and adopt *Kibatalia* for the group as proposed by G. Don.

KIBATALIA LONGIFOLIA sp. nov.

Arbor glabra; foliis chartaceis, oblongis, usque ad 17 cm longis, basi acutis, apice acutis vel breviter acuminatis, nervis utrinque circiter 10, tenuibus, vix anastomosantibus; inflorescentiis 2- vel 3-floris, breviter pedunculatis, corollae tubo circiter 2.5 cm longo, lobis 4 cm longis; folliculis subligneis, rectis vel leviter curvatis, 17 ad 20 cm longis, 2 cm diametro.

A glabrous tree, about 16 m high, the branchlets smooth, reddish-brown, the branches of about the same color and distinctly lenticellate. Leaves firmly chartaceous, oblong, 12 to 17 cm long,

[2] Blume, C. L. Rumphia 4 (1848) 25.
[3] Blume, C. L. Fl. Jav. Praef. 1 (1828) VII.
[4] Gen. Syst. 4 (1838) 86.

4.5 to 6.5 cm wide, the base acute, apex acute to very shortly and obscurely acuminate; lateral nerves about 10 on each side of the midrib, slender, distinct, somewhat curved, scarcely anastomosing; petioles 5 to 8 mm long. Inflorescences axillary and terminal, usually 2- or 3-flowered, the peduncles 1 cm long or less, the pedicels 2 to 3 cm in length. Calyx-lobes broadly ovate to elliptic-ovate, rounded to subacute, 4 to 5 mm long. Corolla-tube cylindric for about 1.6 cm, then inflated for about 1 cm, the lobes about 4 cm long. Disk cylindric, 3 to 4 mm high, irregularly and coarsely toothed. Ovary glabrous, ovoid, narrowed upward; style about 2 cm long. Anthers inserted at the expansion of the corolla tube, lanceolate, long-acuminate, about 9 mm long, the basal indurated part of the connective ovoid, about 3 mm long. Follicles somewhat woody, divaricate, straight or slightly curved, 17 to 20 cm long, about 2 cm in diameter. Seeds linear-lanceolate, long-acuminate, about 3 cm long, the coma copious, the hairs about 4 cm in length.

MINDANAO, Davao Province, Santa Cruz, Balutakay, *For. Bur. 27534 De Mesa*, April 28, 1919, growing in deep rich soil at an altitude of 40 meters with the local Tagakaolo name *klangnita*.

The alliance of this species is apparently with *Kibatalia wigmani* (Koord.) Merr. of Celebes, from which it differs conspicuously in its slenderly nerved leaves, the lateral nerves scarcely anastomosing.

### KIBATALIA STENOPETALA sp. nov.

Arbor glabra, circiter 5 m alta, ramulis tenuibus; foliis subcoriaceis, oblongo-ellipticis, 5 ad 7 cm longis, utrinque subaequaliter angustatis, acuminatis, nervis utrinque circiter 6; floribus axillaribus, solitariis vel binis, tubo corollae 1.5 cm longo, cylindrico, intus pubescens, lobis anguste lanceolatis, acuminatis, circiter 2.5 cm longis, 4 mm latis.

A glabrous tree, about 5 m high, the branches nearly black when dry. Leaves subcoriaceous, oblong-elliptic, shining, 5 to 7 cm long, 1.5 to 3 cm wide, subequally narrowed to the blunt-acuminate apex and to the somewhat decurrent-acuminate base; lateral nerves about 6 on each side of the midrib, distinct, the reticulations very obscure; petioles 2 to 4 mm long. Flowers white, axillary, solitary or in pairs, their pedicels about 2 cm long. Calyx-lobes broadly ovate, 1.5 to 2 mm long, acute or obtuse. Corolla-tube cylindric, about 1.5 cm long, 2.5 mm in diameter, not at all enlarged upward, pubescent inside, the lobes narrowly lanceolate, acuminate, about 2.5 cm long, 4 mm wide. Anthers narrowly lanceolate, acuminate, 5 mm long, the indurated base of the connectives broadly ovate, about 1 mm long. Disk obscurely toothed, 1 mm high.

MINDANAO, Surigao Province, *Bur. Sci. 34691 Ramos & Pascasio*, June 14, 1919, along streams at low altitudes at the iron deposit on the northeast coast.

This species is at once distinguished from *Kibatalia blancoi* Merr., to which it is most closely allied, by its cylindric corolla-tubes which are not enlarged upward, and by its narrowly lanceolate corolla-lobes which do not exceed 4 mm in width.

The hitherto described species of this genus are as follows:

**KIBATALIA AFRICANA** (Benth.) comb. nov.

*Kickxia africana* Benth. in Hook. Ic. III **3** (1877–79) 59, *t. 1276*.

Tropical Africa, Kamerun, *Preuss 1382!*

**KIBATALIA ARBOREA** (Blume) G. Don Gen. Syst. 2 (1837) 86.

*Hasseltia arborea* Blume Bijdr. (1826) 1045.
*Kickxia arborea* Steud. Nomencl. ed. 2, **1** (1840) 846; Blume Rumphia **4** (1848) 26, *t. 179, f. l.*
*Kixia arborea* A. DC. Prodr. **8** (1844) 408.

Java, *cult. Hort. Bogor. IV–A–80!, IV–A–80a!, XI–B–186!*

**KIBATALIA BLANCOI** (Rolfe) comb. nov.

*Kickxia blancoi* Rolfe in Journ. Linn. Soc. Bot. **21** (1884) 313.
*Kickxia arborea* F.-Vill. Novis. App. (1880) 132; Naves in Blanco Fl. Filip. ed. 3 (1877–83) *t. 428 bis*, non Blume.
*Kickxia merrittii* Merr. in Philip. Journ. Sci. **4** (1909) Bot. 315.
*Kickxia macgregorii* Elm. Leafl. Philip. Bot. **4** (1912) 1457.

A Philippine species widely distributed from northern Luzon southward to Guimaras and Negros, represented by *For. Bur. 26678 Peñas, 25863 Adduru, 25465 Paraiso, 20964 Villamil, 25726 Mabesa, 7649 Curran & Merritt, 11488 Merritt, 21545 Tamesis, 15113 Tabat, Elmer 12373, Wenzel 320*.

**KIBATALIA BORNEENSIS** (Stapf) comb. nov.

*Kickxia borneensis* Stapf in Hook. Ic. IV **7** (1901) *t. 2693*.

Borneo.

**KIBATALIA ELASTICA** (Preuss) comb. nov.

*Kickxia elastica* Preuss in Notizbl. Bot. Gart. Berlin **2** (1899) 353.

Tropical Africa, Kamerun, *Zenker 188!*

**KIBATALIA LATIFOLIA** (Stapf) comb. nov.

*Kickxia latifolia* Stapf in Kew Bull. (1898) 307.

Tropical Africa.

**KIBATALIA SCHEFFERI** (K. Schum.) comb. nov.

*Kickxia schefferi* K. Schum. in Notizbl. Bot. Gart. Berlin **3** (1900) 81.

German East Africa, *herb. Amani 416!*

**KIBATALIA WIGMANI** Koord. in Meded. Lands Plantent. 19 (1898) 521.

Celebes, *Koorders 16045!*

**KIBATALIA ZENKERI** (K. Schum.) comb. nov.

*Kickxia zenkeri* K. Schum. in Notizbl. Bot. Gart. Berlin 3 (1900) 81.

Tropical Africa.

### PARSONSIA R. Brown

**PARSONSIA PHILIPPINENSIS** sp. nov.

Frutex scandens, partibus junioribus cinereo-pubescens; foliis oppositis, subcoriaceis, oblongo-ellipticis ad oblongo-ovatis, 8 ad 13 cm longis, basi leviter acuminatis, apice tenuiter acute acuminatis, nervis utrinque circiter 6, distinctis; inflorescentiis terminalibus, anguste paniculatis, 10 ad 12 cm longis, floribus umbellatim dispositis, extus pubescens, corollae tubo 5 mm longo, filamentis villosis, haud contortis.

A woody vine, the young branchlets and inflorescences sparingly cinereous-pubescent, the branchlets terete, smooth, dark reddish-brown when dry. Leaves subcoriaceous, oblong-elliptic to oblong-ovate, 8 to 13 cm long, 3.5 to 6 cm wide, dárk olivaceous when dry, the base usually somewhat acuminate, apex sharply and slenderly acuminate; lateral nerves about 6 on each side of the midrib, distinct, the reticulations lax; petioles 1 to 2 cm long. Inflorescences terminal, paniculate, peduncled, 10 to 12 cm long, more or less pubescent, the flowers subumbellately arranged at the tips of the primary branches, the lower branches 2 cm long or less. Flowers white, their pedicels about 5 mm long. Calyx-lobes obtuse or rounded, 2 to 2.5 mm long. Corolla-tube about 5 mm long and 3 mm in diameter, somewhat angled, glabrous below, pubescent above, the lobes oblong, 4 mm in length. Disk-lobes broadly ovate, rounded, about 0.6 mm long. Anthers narrowly lanceolate, 3.5 mm long, the filaments villous, not twisted.

MINDANAO, Surigao Province, *Bur. Sci. 34585 Ramos & Pascasio,* April 25, 1919, at the iron deposit on the northeast coast along streams at an altitude of about 500 meters.

The distinguishing characters of the present species are its narrowly paniculate inflorescences and its slenderly acuminate, opposite leaves.

## ASCLEPIADACEAE

### HOYA R. Brown

**HOYA CARDIOPHYLLA** sp. nov. § *Euhoya.*

Planta epiphytica, ramulis leviter pilosis, glabriscentibus; foliis oppositis, late ovatis, basi late rotundatis et perspicue cordatis, apice breviter acute acuminatis, 5 ad 7 cm longis, in siccitate subflaccidis, nervis utrinque circiter 4, patulis, cum reticulis laxis subperspicuis; umbellis multifloris, floribus glabris, circiter 1 cm diametro, corolla rotata, lobis rhomboideo-ovatis, obtusis vel acutis, processibus turgidis, crustaceis, oblongo-ovatis, acuminatis.

An epiphytic vine, the branchlets sparingly pilose, soon becoming glabrous. Leaves heart-shaped, apparently fleshy when fresh, rather flaccid when dry, 5 to 7 cm long, 4.5 to 5 cm wide, pale when dry, glabrous or the younger ones slightly ciliate near the basal margins, the base broadly rounded and distinctly cordate, the sinus acute, the basal lobes broadly rounded, the apex shortly and sharply acuminate; petioles 5 to 7 mm long; lateral nerves about 4 on each side of the midrib, somewhat spreading, anastomosing, the reticulations lax and distinct on both surfaces. Umbels many-flowered, the flowers yellowish-white, usually 5-merous, rarely 4-merous, 10 to 11 mm in diameter, their pedicels about 2 cm long, glabrous. Calyx-lobes triangular-ovate, acute or obtuse, 1 mm long. Corolla rotate, the lobes rhomboid-obovate, about 4 mm long, obtuse or somewhat acute, the tips more or less inflexed. Lower lobe of the coronal processes oblong-ovate, acuminate, turgid, somewhat crustaceous, the upper surface somewhat concave. Staminal column short, sessile.

DINAGAT, *Bur. Sci. 35160 Ramos & Pascasio,* May 13, 1919, on tree trunks at low altitudes.

A species well characterized by its broadly ovate, rather prominently cordate, shortly and sharply acuminate, conspicuously and laxly reticulate leaves.

HOYA RETICULATA sp. nov. § *Euhoya.*

Planta epiphytica, scandens, pedicellis exceptis glabra; foliis coriaceis, ovatis ad oblongo-ovatis, nitidis, 8 ad 12 cm longis, basi late rotundatis, apice tenuiter acute acuminatis, in siccitate utrinque perspicue reticulato-rugosis, nervis utrinque circiter 4, patulis, vix perspicuis; umbellis multifloris, pedunculo usque ad 10 cm longo, pedicellis leviter pubescens; floribus rotatis, circiter 1 cm diametro, glabris, corollae lobis rhomboideo-ovatis, acutis, processibus crustaceis, turgidis, oblongo-ovatis, acutis; folliculis 9 ad 11 cm longis, usque ad 4 mm diametro.

An epiphytic vine, glabrous except the sparingly pubescent pedicels. Leaves fleshy when fresh, coriaceous when dry, ovate to oblong-ovate, shining, 8 to 12 cm long, 4 to 7 cm wide, the base broadly rounded, the apex slenderly and sharply acuminate, the epidermis on both surfaces coarsely reticulate-wrinkled when dry; petioles 1 to 2.5 cm long; lateral nerves about 4 on each side of the midrib, somewhat spreading. Umbels many-flowered, their peduncles 2 to 10 cm in length, the somewhat thickened parts marked with scars of fallen pedicels, 1 to 6 cm in length, the pedicels 1.5 to 2 cm long, slightly pubescent. Flowers rotate, glabrous, about 1 cm in diameter, yellowish-white. Calyx-lobes ovate, acute, about 1 mm long. Corolla lobes 4 to 4.5 mm long, about 3.5 mm wide, rhomboid-ovate, acute, spreading, glabrous. Coronal processes crustaceous, the lower lobes turgid, oblong-ovate, acute, about 2.5 mm long, the upper surface flat. Staminal column short, sessile. Follicles slender, cylindric, somewhat acuminate, 9 to 11 cm long, up to 4 mm in diameter, the seeds terete, about 3 mm long.

MINDANAO, Surigao Province, *Bur. Sci. 34530 Ramos & Pascasio,* April 17, 1919, in swampy thickets at low altitudes.

This species is manifestly allied to *Hoya cardiophylla* described above but is readily distinguished by its differently shaped, slenderly acuminate leaves which are broadly rounded but not cordate at the base, its pubescent pedicels, and other characters.

### TELOSMA Coville

#### TELOSMA PARVIFLORA sp. nov.

Planta scandens, glabra; foliis membranaceis, ovatis, 15 ad 18 cm longis, perspicue cordatis, apice tenuiter acuminatis; inflorescentiis laxis, calycis lobis 2 mm longis; corollae tubo cupulato, 3 mm longo, lobis anguste lanceolatis, acuminatis, circiter 6 mm longis; folliculis acuminatis, usque ad 15 cm longis.

A glabrous vine, the branches up to 5 mm in diameter. Leaves membranaceous, ovate, olivaceous, 15 to 17 cm long, 9 to 12 cm wide, the base prominently cordate, the apex rather abruptly and slenderly acuminate; lateral nerves about 5 on each side of the midrib, prominent, the reticulations lax, distinct. Inflorescences axillary, lax, the flowers greenish-yellow, their pedicels 5 to 7 mm long. Calyx-lobes oblong, membranaceous, 2 mm long. Corolla glabrous, the tube cup-shaped, about 3 mm long, wider than long, the lobes narrowly lanceolate, acuminate, about 6 mm in length. Ovary, stamens and corona about 2 mm long and wide, the free tips of the coronal processes ovate, acute or slightly acuminate, about 0.5 mm long. Follicles lanceolate in outline, acuminate, narrowed below to the acute or abruptly obtuse base, 13 to 15 cm long, when dry and somewhat flattened 3 to 4 cm wide. Seeds thin, brownish, ovate, about 1.2 cm long, rounded, the coma copious. Peduncles of the infructescences elongated, including the few branches up to 15 cm in length.

SIARGAO, *Bur. Sci. 35011 Ramos & Pascasio,* May 27, 1919, in dry forests at low altitudes.

In the genus, if correctly placed, this species is easily recognized by its short corolla-tube and its slender corolla-lobes.

## VERBENACEAE

### CALLICARPA Linnaeus

**CALLICARPA LONGIVILLOSA** sp. nov.

Arbor parva, ramulis et petiolis densissime et longe ferrugineo-villosis; foliis chartaceis, oblongo-ovatis, 18 ad 25 cm longis, integris vel subintegris, apice tenuiter longissime caudato-acuminatis, basi acutis, utrinque plus minusve stellato-tomentosis, nervis utrinque 10 ad 12; cymis axillaribus, longe pedunculatis, usque ad 10 cm diametro, bracteis linearis, 5 ad 7 mm longis; calycis dense stellato-tomentosis, obscure 4-dentatis, 2 mm longis.

A tree, about 5 m high. The branches and petioles densely villous with long, spreading, ferruginous hairs. Leaves chartaceous, oblong-ovate, entire, 18 to 25 cm long, 8 to 10 cm wide, narrowed upward to the very slender, caudate acumen, the latter up to 5 cm in length, base acute, usually inequilateral, both surfaces more or less stellate-pubescent and with elongated simple hairs on the midrib and nerves, the indumentum dense only on the midrib and nerves; lateral nerves 10 to 12 on each side of the midrib, distinct as are the reticulations on the lower surface; petioles about 4 cm long. Cymes axillary, long-peduncled, about 12 cm long including the peduncle and up to 10 cm in diameter, dichotomous, stellate-pubescent and villous, the bracts linear, 5 to 7 mm long. Flowers violet, 4-merous. Calyx cup-shaped, densely stellate-pubescent, obscurely 4-toothed, about 2 mm long and wide. Corolla puberulent, the tube cylindric, 3 mm long and the lobes broadly oblong, rounded, 1.3 mm long. Stamens exserted, the anthers about 2 mm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34538 Ramos & Pascasio,* April 19, 1919, in forests along streams at low altitudes.

The prominent characteristics of this species are its densely ferruginous-villous branches, branchlets, and petioles, similar simple hairs being intermixed with the stellate indumentum on other parts of the plant; its very slenderly acuminate, entire leaves; and its long-peduncled inflorescences.

**CALLICARPA FASCICULIFLORA** sp. nov.

Frutex vel arbor parva, partibus junioribus villosis, ramis et foliis et inflorescentiis stellato-tomentosis; foliis oblongis ad ellipticis, 13 ad 24 cm longis, tenuiter acuminatis, nervis utrinque circiter 10; floribus fasciculatis, sessilibus vel breviter pedicellatis, fasciculis plerumque in axillis defoliatis, 1 ad 1.5 cm diametro; calycis dense villosis atque stellato-tomentosis, tubo 3 mm longo, dentibus lanceolatis, acuminatis, 1.5 ad 2 mm longis.

A shrub or small tree, the younger parts villous and stellate-tomentose, especially the branchlets and petioles. Leaves thinly chartaceous, oblong to elliptic, 13 to 24 cm long, 6 to 12 cm wide, the upper surface olivaceous, sparingly stellate-pubescent, becoming glabrous or nearly so, the lower surface pale, stellate-pubescent on the midrib, nerves, and reticulations, base acute, apex rather slenderly acuminate, margin entire or very obscurely and distantly toothed; lateral nerves about 10 on each side of the midrib, distinct; petioles 1 to 2 cm long. Inflorescences mostly in the axils of fallen leaves, the flowers fascicled, sessile or shortly pedicelled, the fascicles rather dense, 1 to 1.5 cm in diameter. Bracts narrowly oblong, stellate-pubescent, 4 to 5 mm long, the bracteoles filiform, 3 mm long. Calyx densely villous and stellate-tomentose, the tube cylindric, 3 mm long, the teeth 4, lanceolate, acuminate, 1.5 to 2 mm long. Corolla pale violet, the tube 4 mm long, externally somewhat pubescent, the lobes 4, oblong, rounded, about 2 mm long. Stamens exserted, the anthers 3 mm long. Fruit globose, about 2.5 mm in diameter, glabrous, inclosed by the calyx.

BUCAS GRANDE, *Bur. Sci. 35123 Ramos & Pascasio*, June 9, 1919, in open forests at low altitudes.

This species is readily distinguished from its congeners by its fascicled, sessile or subsessile flowers, this type of inflorescence being unknown to me in any other species of the genus.

## ACANTHACEAE

### GYMNOSTACHYUM Nees

**GYMNOSTACHYUM SPICIFORME** (Elm.) comb. nov.

*Justicia spiciformis* Elm. Leafl. Philip. Bot. 1 (1908) 349.

LEYTE, Palo, *Elmer 7347*, January, 1906.

This species is known only from the type collection, and is clearly a species of *Gymnostachyum*, agreeing in all characters with the typical representatives of the genus.

**GYMNOSTACHYUM LONGISPICATUM** sp. nov.

Herba erecta, usque ad 50 cm alta, plus minusve pubescens; foliis oblongis ad elliptico-oblongis, 10 ad 15 cm longis, obtusis, nervis utrinque circiter 6; spicis elongatis, usque ad 20 cm longis, multifloris; floribus alternis, bracteis bracteolisque ovatis, acuminatis, glabris vel subglabris, calycis lobis lanceolatis; capsulis lineari-oblongis, glabris, circiter 1.5 cm longis, seminibus circiter 10.

An erect, sparingly branched, more or less pubescent herb, up to 50 cm high. Leaves membranaceous or chartaceous, dark-colored when dry, oblong to elliptic-oblong, 10 to 15 cm long, 4 to 8 cm wide, the base obtuse to acute on the lower ones, the uppermost ones sometimes cordate, the apex obtuse or rounded, margins somewhat undulate, the upper surface glabrous or nearly so, dark olivaceous, the lower somewhat pubescent on the midrib and nerves; lateral nerves about 6 on each side of the midrib, slender, distinct; petioles of the lower leaves up to 2 cm long, of the uppermost ones 5 mm long or less. Spikes elongated, up to 20 cm in length, many-flowered, the flowers alternate, sessile, white, the subtending bracts ovate, acuminate, 2 mm long, the bracteoles similar but slightly smaller, glabrous or nearly so. Calyx 3 to 3.5 mm long, the tube 1.5 mm in length, the lobes lanceolate, acuminate. Corolla-tube 3 mm long, the upper lobe broadly ovate, erect, 3 mm long, the lower one spreading, 3-lobed, each lobe elliptic-oblong, about 3 mm long, 2 to 2.5 mm wide, anther about 2 mm long. Capsule linear-oblong, glabrous, about 1.5 cm long and 2 mm wide, each valve carrying about 5 seeds.

SIARGAO, *Bur. Sci. 34999 Ramos & Pascasio,* May 27, 1919, in thickets or forests at low altitudes.

A species well characterized by its ample leaves and by its greatly elongated spikes.

## GESNERIACEAE

### CYRTANDRA Forster

**CYRTANDRA CAULIFLORA** sp. nov.

Frutex erectus, foliis oppositis, aequalibus, perspicue ferrugineo- vel castaneo-villosus; foliis oblanceolatis ad oblongo-oblanceolatis, 10 ad 20 cm longis, tenuiter acuminatis, basi cuneatis, margine perspicue dentatis, supra subglabris, nervis utrinque circiter 8; inflorescentiis caulinis et e ramis majoribus, cymosis, circiter 5 cm longis, dense villosis; calycis circiter 1.5 cm longis, lobis linearis, 1 cm longis; corolla 2 cm longa.

An erect shrub, the leaves opposite, those of each pair subequal, the branchlets, petioles, inflorescences, and leaves on the lower surface conspicuously ferruginous- or castaneous-villous with weak spreading hairs. Leaves oblanceolate to oblong-oblanceolate or the lower ones sometimes lanceolate, 10 to 20 cm long, 2 to 6 cm wide, the apex rather slenderly acuminate, narrowed below to the cuneate base, the margins conspicuously toothed, especially toward the apex where the teeth are large and irregular, the upper surface dark-olivaceous with very few widely scattered, weak hairs, ultimately glabrous or nearly so, the lower surface conspicuously and softly villous; lateral nerves about 8 on each side of the midrib, prominent, the reticulations very lax; petioles 2 to 3 cm long. Inflorescences from the trunk or larger branches below the leaves, peduncled, cymose, all parts densely villous with weak spreading hairs, the peduncles 1 to 2 cm long, the pedicels 5 to 8 mm long, the subtending bracts lanceolate or linear-lanceolate, 1 cm long or less. Calyx including the very slender lobes about 1.5 cm long, the lobes linear, about 1 cm in length. Corolla slender, about 2 cm long, externally prominently villous. Style somewhat pubescent.

PANAY, Capiz Province, Libacao, *Bur. Sci. 35342 Martelino & Edaño*, June 3, 1919, along streams at low altitudes, the flowers white.

This species apparently belongs in the group with *Cyrtandra ramiflora* Elm., from which *C. laxa* Elm. is scarcely distinguishable. It differs radically from the above species in its totally different leaves, flowers, and inflorescences.

### TRICHOSPORUM D. Don

#### TRICHOSPORUM PANAYENSE sp. nov.

Planta scandens, partibus junioribus parce pilosis vel glabris; foliis coriaceis, oblongo-ovatis ad oblongis, usque ad 6 cm longis, basi rotundatis, apice acutis vel obtusis; floribus axillaribus, solitariis vel binis, glabris vel subglabris, calycis subtruncatis, cylindraceis, 1.2 ad 1.5 cm longis, corolla leviter curvata, 4 ad 4.5 cm longa.

A scandent vine, the stems up to 3 mm in diameter, the younger parts sparingly pilose with weak, widely scattered hairs, soon becoming glabrous or nearly so. Leaves fleshy when fresh, coriaceous when dry, oblong-ovate to oblong, 2.5 to 6 cm long, 1.5 to 2.5 cm wide, the base rounded, the apex acute or obtuse; lateral nerves usually 4 on each side of the midrib, often obsolete, never prominent; petioles about 5 mm long. Flowers axillary, usually 2 on each peduncle, the peduncle less than 5 mm long. Calyx cylindric, truncate or somewhat angulate, 1.2 to 1.5 cm long, usually glabrous. Corolla apparently reddish, somewhat curved, 4 to 4.5 cm long, glabrous or nearly so, the lobes ovate to ovate-elliptic, rounded, about 7 mm long. Capsules slender, up to 20 cm long, about 3 mm in diameter, glabrous.

PANAY, Mount Bulilao, Mount Salibongbong, and Libacao, *Bur. Sci. 35720* (type), *35392, 35535, 35588, 35676 Martelino & Edaño,* June, 1919, in forests along streams, ascending to an altitude of 600 meters.

In general this species resembles, and is manifesty allied to, *Trichosporum truncatum* Elm. and T. *bakeri* Merr.; but the calyx is half as long as in the latter, while it differs from the former in several characters.

## RUBIACEAE

### TIMONIUS de Candolle

**TIMONIUS ROTUNDUS** sp. nov.

Arbor glabra, circiter 5 m alta; foliis crasse coriaceis, late elliptico-ovatis, nitidis, apice late rotundatis, basi subtruncatis ad acutis, nervis utrinque 4 vel 5, valde perspicuis; infructescentiis axillaribus, pendunculatis, usque ad 10 cm longis, dichotome ramosis, ramis primariis usque ad 7 cm longis; fructibus sessilibus, depresso-globosis, glabris, 5 ad 8 mm diametro.

A small glabrous tree, about 5 m high, the branchlets about 6 mm in diameter, marked with large petiolar scars. Leaves thickly coriaceous, broadly elliptic-ovate, brownish-olivaceous and shining when dry, the apex broadly rounded, base subtruncate to acute; lateral nerves 4 or 5 on each side of the midrib, very prominent, the reticulations fine, dense; petioles about 4 cm long; stipules oblong-elliptic, rounded, about 2 cm long, deciduous. Infructescences axillary, peduncled, up to 10 cm long, dichotomously branched, the peduncles about 3 cm long, the primary branches up to 7 cm in length, the secondary ones when present shorter. Fruits sessile, arranged on one side of the primary or secondary branches, depressed-globose, pale when dry, 5 to 8 mm in diameter.

DINAGAT, *Bur. Sci. 35176 Ramos & Pascasio,* May 17, 1919, in forests at low altitudes.

A species apparently belonging in the group with *Timonius obovatus* Elm. but with very differently shaped, much larger leaves.

**TIMONIUS PANAYENSIS** sp. nov.

Arbor dioica, partibus junioribus inflorescentiisque ferrugineo pubescens; foliis variabilis, 12 ad 28 cm longis, coriaceis, oblongis ad ovato-ellipticis vel obovato-ellipticis, breviter acuminatis, basi acutis, subtus leviter pubescens, nervis utrinque circiter 10, valde perspicuis, inflorescentiis ♂ circiter 4 cm longis, pedunculatis, dichotome ramosis, ramis 2, paucifloris; floribus sessilibus, calycis cylindraceis, 10 ad 12 mm longis, 2- vel 3-lobatis; fructibus pedunculatis, solitariis, ellipsoideis, circiter 1.5 cm diametro, ferrugineo-pubescens, calycis tubo persistentibus, cylindraceis.

A dioecious tree, 10 to 15 m high, the younger parts and inflorescences distinctly ferruginous-pubescent with short, appressed hairs. Branches terete, glabrous, the ultimate branchlets somewhat angled, pubescent. Leaves opposite, exceedingly variable in size, coriaceous, oblong to ovate-elliptic or obovate-elliptic, shortly acuminate, base acute, the upper surface glabrous, the lower sparingly pubescent, 12 to 28 cm long, 5 to 14 cm wide; lateral nerves very prominent, about 10 on each side of the midrib, the primary reticulations lax, distinct; petioles when young pubescent, in age nearly glabrous, 5 to 10 mm long; stipules oblong-ovate, shortly acuminate, pubescent, about 12 mm long. Staminate inflorescences axillary, ferruginous-pubescent, about 4 cm long, peduncled, dichotomously once-branched, few-flowered. Flowers ferruginous-pubescent, sessile. Calyx cylindric, 10 to 12 mm long, irregularly 3-toothed or 3-lobed, the teeth broad, 2 to 3 mm long. Corolla-tube about 6 mm long, the lobes 5, oblong, 5 mm in length. Fruits apparently solitary, the peduncles 2 to 2.5 cm long, the fruits ellipsoid, appressed-pubescent with short, shining, ferruginous hairs, smooth, about 1.5 cm in diameter, crowned by the elongated, persistent, cylindric calyx-tube which is about 8 mm in length.

PANAY, Capiz Province, Libacao, *Bur. Sci. 35445* (type), *35447 Martelino & Edaño,* June 13, 1919, in open forests and along small streams at low altitudes.

This species is characterized by its exceedingly variable leaves; its elongated staminate flowers; and its ellipsoid fruits which are crowned by the cylindric, persistent, elongated calyx-tube.

### TIMONIUS LANCEOLATUS sp. nov.

Frutex dioicus, circiter 3 m altus, partibus junioribus et subtus foliis ferrugineo-pubescens; foliis coriaceis, lanceolatis, nitidis, 7 ad 13 cm longis, utrinque angustatis, basi cuneatis, apice tenuiter acuminatis, nervis utrinque 5 ad 7, distinctis, reticulis subobsoletis; floribus ♂ axillaribus, sessilibus, fasciculatis, calycis tubo 3 ad 4 mm longo, lobis lanceolatis, tubo aequantibus, patulis; fructibus axillaribus, solitariis, brevissime pedicellatis, depresso-globosis, 6 ad 9 mm diametro, dense pubescens.

A shrub, about 3 m high, the younger parts, flowers, and leaves on the lower surface more or less ferruginous-pubescent. Branches grayish to reddish-brown, terete, glabrous, the growing branchlets densely ferruginous-pubescent with short appressed hairs. Leaves coriaceous, lanceolate, brownish-olivaceous when dry, shining, 7 to 13 cm long, 2 to 4.5 cm wide, narrowed to the slenderly acuminate apex and below to the cuneate base, the upper surface glabrous, the lower somewhat paler and appressed-pubescent with short hairs; lateral nerves 5 to 7 on each side of the midrib, distinct, the reticulations very obscure or often obsolete; petioles 3 mm long or less; stipules lanceolate, acuminate, about 8 mm long, connate below, deciduous. Male flowers axillary, sessile, fascicled, ferruginous-pubescent, usually 3 or 4 in a fascicle, the bracts linear-lanceolate, acuminate, 2.5 to 4 mm long. Calyx-tube 3 to 4 mm long, the lobes 5, rarely 6, lanceolate, acuminate, 3 to 4 mm long, somewhat spreading. Corolla-tube about 1 cm long, the lobes oblong, 4 mm in length. Fruits axillary, usually solitary, depressed-globose or globose, 6 to 9 mm in diameter, densely pubescent with shining, short, brownish hairs, the pedicels about 2 mm long.

DINAGAT, *Bur. Sci. 35211 Ramos & Pascasio* (type), May 12, 1919. MINDANAO, Surigao Province, *Bur. Sci. 34613 Ramos & Pascasio,* April 24, 1919. In forests at low altitudes.

This species somewhat resembles *Timonius longistipulus* Merr., but its true alliance seems to be with *T. valetonii* Elm., from which it is distinguished by its entirely differently shaped leaves.

### GREENIOPSIS Merrill

**GREENIOPSIS EUPHLEBIA** sp. nov.

Arbor parva, plus minusve hirsuta, ramulis dense hirsutis; foliis chartaceis, oblongo-obovatis ad oblongo-oblanceolatis, breviter petiolatis, 16 ad 23 cm longis, 5 ad 10 cm latis, nitidis, in siccitate brunneis, apice acute acuminatis, basi anguste cuneatis, supra glabra, subtus ad costa nervisque hirsutis; nervis utrinque circiter 15, supra impressis, subtus valde conspicuis; paniculis terminalibus, pedunculatis, usque ad 26 cm longis, omnibus partibus hirsutis, corolla circiter 1 cm longa.

A tree, about 4 m high, rather prominently hirsute, the branchlets and inflorescences densely so, the indumentum brownish or ferruginous. Leaves oblong-obovate to oblong-oblanceolate, chartaceous, brown and shining when dry, 16 to 23 cm long, 5 to 10 cm wide, the apex shortly and sharply acuminate, the base narrowly cuneate, the upper surface glabrous or with few hairs along the midrib, the lower surface hirsute on the midrib and nerves; lateral nerves about 15 on each side of the midrib, impressed on the upper surface, very prominent on the lower surface; petioles 1 cm long or less; stipules oblong-lanceolate, glabrous, or the median part pubescent, acuminate, 2 to 2.5 cm long, brown when dry. Panicles peduncled, terminal, up to 26 cm long, usually supplied with a few reduced leaves, all parts rather prominently hirsute. Flowers numerous, white, their pedicels 1 to 2 mm long. Calyx 6 mm long, funnel-shaped, the lobes 5, obovate to oblong-obovate, rounded, 3 mm long. Corolla 1 cm long, pubescent, funnel-shaped, the tube about 22 mm in diameter for the lower 3 mm, then expanded, the throat 6 to 7 mm in diameter, the lobes about 2 mm long and 4 mm wide, broadly rounded or retuse, the tube villous inside in the narrower part. Anthers 2 mm long.

BUCAS GRANDE, *Bur. Sci. 35134 Ramos & Pascasio*, June 9, 1919, in open forests at low altitudes.

This species is well characterized by its indumentum and by its very prominently nerved leaves, and is readily distinguishable from the other described species of the genus.

### IXORA Linnaeus

**IXORA ANGUSTILIMBA** sp. nov.

Frutex glaber, 1 ad 2 m altus; foliis lanceolatis ad anguste lanceolatis, subcoriaceis, 7 ad 22 cm longis, 1 ad 3 cm latis, basi acutis, apice acute acuminatis, nervis utrinque circiter 20, tenuibus; cymis 6 ad 12 cm longis, laxis, pedunculatis, floribus plerumque in triadibus dispositis, calycis dentibus brevissimis, corollae tubo 1.8 cm longo, lobis anguste oblongis, 5 ad 6 mm longis.

A glabrous shrub, 1 to 2 m high. Leaves lanceolate to narrowly lanceolate, subcoriaceous, 7 to 22 cm long, 1 to 3 cm wide, subequally narrowed below to the usually acute base and above to the sharply acuminate apex, shining when dry, often somewhat falcate; lateral nerves slender, spreading, often indistinct, up to 20 on each side of the midrib; petioles 2 mm long or less, stout; stipules truncate, abruptly terminated by a 1.5 to 2 mm long acuminate tip. Inflorescences terminal and in the upper axils, usually solitary, 6 to 12 cm long, peduncled, the flowers rather laxly disposed; the primary branches up to 4 cm in length. Flowers reddish-white, usually borne in triads at the tips of the ultimate branches, their pedicels about 5 mm long, the subtending bracts lanceolate, acuminate, 1.5 mm long or less, the bracteoles subtending, the flowers similar but smaller. Calyx about

2 mm long, the teeth very short. Corolla-tube slender, about 1.8 cm long, the lobes narrowly oblong, spreading or reflexed, 5 to 6 mm long. Fruits ovoid, red when fresh, dark brown when dry, 6 to 8 mm in diameter.

MINDANAO, Surigao Province, *Bur. Sci. 34588 Ramos & Pascasio* (type), April 24, 1919. DINAGAT, *Bur. Sci. 35222 Ramos & Pascasio,* June, 1919. BUCAS GRANDE, *Bur. Sci. 35087 Ramos & Pascasio,* June 11, 1919. On dry forested slopes and ridges at low altitudes.

A species strongly characterized by its narrow, elongated leaves, apparently not closely allied to any previously described form.

### IXORA TENUIPEDUNCULATA sp. nov.

Frutex glaber, foliis chartaceis, oblanceolatis, 9 ad 13 cm longis, 2 ad 3 cm latis, deorsum angustatis, basi cuneatis, apice acuminatis, nervis utrinque circiter 20; inflorescentiis axillaribus, solitariis, 3-floris, tenuiter pedunculatis, pedunculo 5 ad 6 cm longo; calycis dentibus brevissimis, corollae tubo 2.8 cm longo, lobis lineari-lanceolatis, circiter 1.2 cm longis.

A glabrous shrub. Leaves chartaceous, oblanceolate, rather pale and somewhat shining when dry, 9 to 13 cm long, 2 to 3 cm wide, narrowed below to the cuneate base, the apex distinctly acuminate; lateral nerves slender, spreading at nearly right angles, about 20 on each side of the midrib; petioles rather stout, 2 to 3 mm long; stipules broad, subtruncate, terminated by a 5-mm long filiform tip. Inflorescences axillary, solitary, 3-flowered, their peduncles very slender, 5 to 6 cm long, the pedicels slender, about 1 cm long. Flowers pink, the calyx about 2 mm long, the teeth very short. Corolla-tube slender, about 2.3 cm long, the lobes linear-lanceolate, about 1.2 cm long. Fruits brown when dry, about 7 mm long and nearly 1 cm wide.

MINDANAO, Surigao Province, *Bur. Sci. 34475 Ramos & Pascasio,* April 30, 1919, in damp forests at low altitudes.

A species strongly characterized by its 3-flowered inflorescences and its very slender elongated peduncles.

### IXORA CONFERTIFLORA sp. nov.

Frutex glaber, circiter 3 m altus; foliis coriaceis, oblongo-ellipticis ad oblongo-obovatis, 9 ad 13 cm longis, basi cuneatis, apice acute acuminatis, nervis utrinque circiter 12, tenuibus; stipulis tenuiter caudato-acuminatis; cymis subcapitatis, pedunculatis, axillaribus terminalibusque, 1.5 ad 3 cm diametro, pedunculo 2 ad 6 cm longo; bracteis bracteolisque linearis, 2.5 ad

4 mm longis, calycis dentibus oblongis ad oblongo-ellipticis, quam tubo paullo longioribus, corollae tubo 10 ad 12 mm longo, lobis ellipticis, 2.5 mm longis.

A glabrous shrub, about 3 m high. Leaves coriaceous, dark brown and shining when dry, oblong-elliptic to somewhat oblong-obovate, 9 to 13 cm long, 3 to 5.5 cm wide, the base cuneate, the apex sharply acuminate; lateral nerves spreading at nearly right angles, about 12 on each side of the midrib, slender, distinct, the reticulations evident; petioles 5 mm long or less; stipules broadly ovate, abruptly contracted into a slender, caudate, 5 to 7 mm long tip. Cymes subcapitate, peduncled, axillary, and terminal, 1.5 to 3 cm in diameter, few- to many-flowered, their peduncles 2 to 6 cm long, the terminal one usually subtended by a pair of ovate to broadly ovate, rounded, or cordate, sessile leaves, 3 to 5 cm in length. Flowers white, the subtending bracts and bracteoles linear, 2.5 to 4 mm long. Calyx-tube somewhat ovoid, about 2 mm long, the lobes oblong to oblong-elliptic, acute, usually exceeding the tube in length. Corolla-tube slender, 10 to 12 mm long, the lobes elliptic, 2.5 mm in length. Fruits red when fresh, dark brown when dry, ovoid, 5 to 7 mm in diameter, crowned by the conspicuous calyx-lobes.

DINAGAT, *Bur. Sci. 35206 Ramos & Pascasio*, May 12, 1919, in forests at low altitudes.

This species somewhat resembles *Ixora capitulifera* Merr. but differs very radically in its calyx characters. It is easily recognizable by its subcapitate, dense, panicled cymes; its very slender bracts and bracteoles; its calyx-teeth distinctly exceeding the tube in length; and in its rather short, white flowers.

## CAMPANULACEAE

### PENTAPHRAGMA Wallich

**PENTAPHRAGMA PLATYPHYLLA** sp. nov.

Planta erecta, 0.5 m alta, partibus junioribus dense pubescens; foliis late ovatis ad elliptico-ovatis, chartaceis, leviter inaequilateralibus, usque ad 28 cm longis, basi, saltem in foliis majoribus, distincte cordatis, nervis utrinque circiter 6; racemis axillaribus, pubescens, bracteis anguste oblongis; floribus haud secundis, pedicellatis, tubo perianthii pubescens, 3 cm longo, calycis lobis inaequalibus, majoribus usque ad 2.5 cm longis.

A suffrutescent plant, about 0.5 m high, the younger parts densely pubescent with crisped hairs. Leaves broadly ovate to elliptic-ovate, slightly inequilateral, chartaceous, up to 28 cm long and 20 cm wide, the upper surface glabrous, the lower more or less pubescent with scattered hairs, the apex subacute, the margin with distant, short, blunt teeth, base somewhat inequilateral, distinctly cordate, at least that of the larger leaves; lateral nerves about 6 on each side of the midrib, prominent; petioles up to 10 cm long. Inflorescences axillary, the rachis and peduncle up to 8 cm long, pubescent, the bracts narrowly oblong, about 1 cm long. Flowers white, not secund, their pedicels about 1.5 cm long, gradually merging with the perianth-tube which is up to 3 cm in length, terete or obscurely angled and more or less pubescent. Calyx lobes white, spreading, elliptic, the two larger ones 2 to 2.5 cm long, about 1.5 cm wide, rounded, the three others smaller, usually about half as large as the other two. Petals 5, oblong to narrowly oblong-obovate, rather thick, rounded, about 10 mm long, 5 to 6 mm wide.

DINAGAT, *Bur. Sci. 35258 Ramos & Pascasio,* May 12, 1919, in forests along small streams at low altitudes.

A species belonging in the same group with *Pentaphragma philippinense* Merr., from which it differs especially in its larger leaves, which are cordate at the base.

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## ACTION OF SOME FUNGICIDES ON THE CITRUS-CANKER ORGANISM

### A PROGRESS REPORT


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Experiments to determine the possibility of control by spraying methods of the bacterial disease, citrus canker, were undertaken by the writer in 1917. In developing this work it became desirable to understand more in detail the action of certain fungicides against *Pseudomonas citri* Hasse, the cause of the disease. Experiments were therefore undertaken to determine the toxic action of the common fungicides by the methods proposed by Anderson and McClintic[2] for obtaining the phenol coefficient of disinfectants.

A paper by Jehle[3] has already presented experiments upon the action of disinfectants on *Pseudomonas citri*. Jehle's tests were made by means of Hill's method, the glass-rod method, the platinum-loop method, and the filter-paper method. His work


[1] Appreciation is hereby expressed to Dr. O. Schöbl, bacteriologist in charge of the serum division, and to Mr. A. H. Wells, chief of the division of organic chemistry of the Bureau of Science, for many helpful suggestions. Thanks are also due to Mr. Mariano G. Medalla, assistant pathologist of the Bureau of Agriculture, for loyal assistance throughout the experiments.


[2] Anderson, John F., and McClintic, Thomas B., Method of standardizing disinfectants with and without organic matter, Bull. Hyg. Lab. 82 (1912).

[3] Jehle, R. A., Effect of disinfectants upon Bacterium citri, Quarterly Bull. States Plant Board Florida, No. 2, 2 (January, 1918) 112.

was found very helpful to the present writer's problems, but listed results with only such disinfectants as mercuric bichloride, lysol, formaldehyde, etc.; Bordeaux mixtures, lime sulphur, and Burgundy mixtures were not reported upon. Data upon these last-mentioned fungicides were expected to be of value in our control problems, and tests with them were therefore begun. The method of Anderson and McClintic seemed to be the simplest and most desirable for this work. The following is a presentation of data obtained from these experiments:

### BRIEF RÉSUMÉ OF METHODS OF ANDERSON AND McCLINTIC

Methods were devised by these investigators to test disinfectants both in the presence and in the absence of organic matter, using a standardized culture of *Bacillus typhosus*. In the work reported in the present paper, *Pseudomonas citri* of course was used for the tests. Since the choice of the organic matter in their methods was entirely empirical, it would seem that the tests in the absence of organic matter were most desirable for this problem. In either case the results in the present tests are for the most part comparative and cannot be considered as directly applicable.

The tests without organic material were made by exposing a carefully measured volume of a standardized culture of *Pseudomonas citri* to various dilutions of the disinfectants. Each dilution of each disinfectant was tested for periods of 2½, 5, 7½, 10, 12½, and 15 minutes. The standardized culture in our experiments was a 3-day-old culture of *Pseudomonas citri* which had been previously transferred successively from 3-day-old bouillon cultures. The bouillon used was the standard nutrient beef peptone bouillon +1.5.

The culture to be used for the tests was first cooled to 20° C., and by means of sterile pipettes 0.1 cubic centimeter of this culture was then added to each of ten tubes, each containing 5 cubic centimeters of the dilutions of fungicides to be tested; these dilutions were also cooled and maintained at 20° C. The seeding tubes were then rotated to distribute the organisms throughout the disinfectant, and at the end of the periods of exposure one loopful of the mixed disinfectant and culture was removed by means of carefully standardized 3-millimeter platinum loops, flamed of course. The loopful of inoculated fungicide was then immediately transferred to a tube of nutrient beef bouillon +1.5; the killing of the canker bacteria was indicated by the absence of clouding in the bouillon tube. The presence of cloudiness in such a bouillon tube indicated the presence of citrus-canker organisms not killed by the fungicide. Since contaminations were possible, a test was made in all doubtful cases to show the identity of the clouding organism. The diagnosis for *Pseudomonas citri* is very simple and consists of a characteristic growth on potato plugs. Bouillon tubes which were of a suspicious character were therefore tested by this means to confirm the presence or absence of the canker bacteria.

Attention was mainly given to the principal fungicides which were found to be of possible use against canker. These were for the most part the standard fungicides which have been in use in the United States for the last decade. The results of these tests are best shown in the tabular form in which they are recorded in the card index; the tables follow:

TABLE 1.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of phenol.*

[Date of test, February 2, 1920; date of observation, February 5, 1920.]

| Exposure. | | Dilution expressed in percentage. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| *Min.* | *sec.* | | | | | | | | | | |
| 2 | 30 | + | — | — | — | — | — | — | — | — | — |
| 5 | 00 | + | — | — | — | — | — | — | — | — | — |
| 7 | 30 | + | — | — | — | — | — | [a]— | — | — | — |
| 10 | 00 | + | — | — | — | — | — | — | — | — | — |
| 12 | 30 | + | — | — | — | — | [a]— | — | — | — | — |
| 15 | 00 | + | — | — | — | — | — | — | — | — | — |

[a] Tube tested for *P. citri*, February 5, 1920; negative, February 9, 1920.

The test was repeated using dilutions with water of 1 to 60, 1 to 80, 1 to 100, 1 to 120, and 1 to 140. All remained negative. Repeating the test with dilutions 1 to 80, 1 to 100, 1 to 120, 1 to 140, and 1 to 160, the last-mentioned dilution showed cloudiness in exposures for 2½, 5, and 7½ minutes, but remained negative in the longer exposures; that is, 10, 12½, and 15 minutes. A repetition of the test gave positive results for dilutions of 1 to 140 for exposures of 2½ and 5 minutes and for those of 1 to 160 exposed 2½, 5, and 7½ minutes. The results thus agree closely for this disinfectant. To summarize: 1 to 120 dilution of phenol killed the canker bacteria in all cases, at all the periods of exposure employed. This was in the entire absence of organic matter which might precipitate or otherwise neutralize the value of the disinfectant; thus a 1 to 100 dilution would be considered more certain of entire disinfection.

Compared with *Bacillus typhosus, Pseudomonas citri* is very slightly more resistant to disinfectants, or to phenol at least, according to these tests. The results of Anderson and McClintic with *B. typhosus* and these with *P. citri* are not directly comparable, however, since a 3-day-old culture was used for our tests, while Anderson and McClintic used a 24-hour culture of *B. typhosus* in their work.

TABLE 2.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of mercuric bichloride.*

[Date of test, February 5, 1920; date of observation, February 7, 1920.]

| Exposure. | | Dilution. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 to 1,000,000. | 1 to 500,000. | 1 to 200,000. | 1 to 100,000. | 1 to 50,000. | 1 to 20,000. | 1 to 10,000. | 1 to 5,000. | 1 to 2,000. | 1 to 1,000. |
| *Min.* | *sec.* | | | | | | | | | | |
| 2 | 30 | + | + | + | [a] + | — | — | — | — | — | — |
| 5 | 00 | + | + | + | + | — | — | — | — | — | — |
| 7 | 30 | + | + | + | + | — | — | — | — | — | — |
| 10 | 00 | + | + | + | + | — | — | — | — | — | — |
| 12 | 30 | + | + | + | + | — | — | — | — | — | — |
| 15 | 00 | + | + | [a] + | + | — | — | — | — | — | — |

[a] Tube tested for *P. citri*, February 7; positive, February 8.

A previous test had been made with dilutions up to 1 to 20,000, all such dilutions giving negative results. Two subsequent tests with dilutions of 1 to 20,000, 1 to 50,000, 1 to 80,000, 1 to 90,000, and 1 to 100,000 gave negative results with the 1 to 20,000; exposures for $2\frac{1}{2}$ and 5 minutes in a dilution of 1 to 50,000 were positive in one case while the longer exposures were negative. In the other case all exposures to a dilution of 1 to 50,000 were positive; in both cases all exposures to dilutions of 1 to 80,000, 1 to 90,000, and 1 to 100,000 resulted positively. Apparently, therefore, a 1 to 20,000 dilution of mercuric bichloride is the weakest dilution possible in the case of this disinfectant in order to secure safely bactericidal action.

A preliminary test having given the rough limits for this disinfectant, the two tests shown in Table 3 were tried, and they showed very close agreement. A fourth test resulted negatively for all the periods of exposure to the 1 to 300 dilution; 1 to 400 dilution was positive at $2\frac{1}{2}$ and 5 minutes exposure, but at longer exposures was negative; all of the 1 to 500 and 1 to 600 dilutions, at all periods of exposure, were positive. Therefore, 1 to 300 seems to be the most dilute solution possible for this disinfectant.

**Table 3.**—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Liquor cresolis compositus.*

| Exposure. | | Dilution. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 to 400. | 1 to 300. | 1 to 200. | 1 to 100. | 1 to 600. | 1 to 500. | 1 to 400. | 1 to 300. | 1 to 200. |
| | | Tested, February 7, 1920; observed, February 10, 1920. | | | | Tested, April 28, 1920; observed, April 30, 1920. | | | | |
| *Min.* | *sec.* | | | | | | | | | |
| 2 | 30 | + | — | — | — | + | + | + | — | — |
| 5 | 00 | — | — | — | — | + | + | — | — | — |
| 7 | 30 | — | — | — | — | + | — | — | — | — |
| 10 | 00 | — | — | — | — | + | — | — | — | — |
| 12 | 30 | — | — | — | — | — | — | — | — | — |
| 15 | 00 | — | — | — | — | — | — | — | — | — |

The kerosene emulsion, the tests of which are reported in Table 4, is a mixture suggested by previous experience for possible use as a disinfectant in canker-control work, also operating as a contact insecticide against scale insects which often become serious on citrus trees following copper sprays. The stock emulsion was prepared by adding 3 parts of kerosene to 1 of *Liquor cresolis compositus.* In a 1 to 50 mixture of this stock solution with water, the *Liquor cresolis compositus* would then be at a dilution of 1 to 200 parts of water.

**Table 4.**—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of kerosene stock emulsion.*

[Date of test, February 5, 1920; date of observation, February 8, 1920.]

| Exposure. | | Dilution. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 to 90. | 1 to 85. | 1 to 80. | 1 to 75. | 1 to 70. | 1 to 65. | 1 to 60. | 1 to 55. | 1 to 50. | 1 to 45. |
| *Min.* | *sec.* | | | | | | | | | | |
| 2 | 30 | + | + | + | + | + | + | [a]+ | — | — | [b]— |
| 5 | 00 | + | + | + | + | + | — | — | [c]— | — | — |
| 7 | 30 | + | + | + | — | — | — | [b]— | — | — | — |
| 10 | 00 | — | — | — | — | — | — | — | [b]— | — | — |
| 12 | 30 | — | — | — | — | — | — | — | — | — | [b]— |
| 15 | 00 | — | — | — | — | — | — | [c]— | — | — | — |

[a] Tube tested for *P. citri*, February 7; positive for *P. citri*, February 8.
[b] Tube tested for *P. citri*, February 7; negative for *P. citri*, February 8.
[c] Tube tested for *P. citri*, February 8; negative for *P. citri*, February 11.

One other test was in such close agreement with the results shown in Table 4 that no further repetitions were made. A 1 to 50 dilution of this emulsion was used in the field. Such a dilution, according to these data, would seem to be entirely safe in the absence of any organic matter which would precipitate or otherwise neutralize the action of the disinfectant.

TABLE 5.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of formalin.*

[Date of test, February 3, 1920; date of observation, February 6, 1920.]

| Exposure. | Dilution. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 to 200. | 1 to 180. | 1 to 160. | 1 to 140. | 1 to 120. | 1 to 100. | 1 to 80. | 1 to 60. | 1 to 40. | 1 to 20. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | + | + | + | + | + | + | [a]+ | + | + | — |
| 5 00 | + | + | + | + | + | + | + | + | — | — |
| 7 30 | + | + | + | + | + | [a]+ | + | — | — | — |
| 10 00 | + | + | + | + | + | + | + | — | — | — |
| 12 30 | + | + | + | + | + | + | [b]— | — | — | — |
| 15 00 | + | + | + | + | [a]+ | [c]+ | — | — | — | — |

[a] Exposure tested, February 5; positive, February 7.
[b] Exposure tested, February 5; negative, February 8.
[c] Exposure tested, February 7; positive, February 8.

Tests with formalin dilutions were made repeatedly in as much as there was a slight degree of variation in the results from exposures of dilutions of 1 to 40, 1 to 60, and 1 to 80. Formalin 1 to 100 at no period of exposure resulted in the killing of the canker bacteria. In one test all exposures at a dilution of 1 to 80 gave similar positive results, although in other tests the exposures for 10, 12½, and 15 minutes were negative. A dilution of 1 to 60 formalin in all tests failed to kill the canker bacteria in 2½ minutes; in one instance also it failed to kill after an exposure of 5 minutes. Two instances also occurred in which 1 to 40 formalin failed to kill at exposures of 2½ minutes although negative results were always obtained at 5-minute exposures. Such variations were probably due to some extent to variations in the content of the commercial formalin solutions used in the different tests. In any event it appears safe to say that, in orchard practice, no formalin solution more dilute than 1 to 20 is a safe disinfectant against the canker bacteria. In the writer's experience a dilution of 1 to 80 was the strongest that trees of *Citrus maxima, C. hystrix, C. nobilis,* or *C. sinensis* would stand without serious burning, under tropical conditions. Trees of *C. limonia* or *C. aurantifolia* are much more susceptible to formalin burning, and a dilution of 1 to 120 was the strongest practicable without causing severe burning. The use of formalin as a spray in orchard work against citrus canker hardly seems feasible, therefore, unless in remote cases it is desirable to remove the leaves of the tree.

TABLE 6.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of lime-sulphur solution.*[a]

[Date of test, February 7, 1920; date of observation, February 9, 1920.]

| Exposure. | Dilution. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 to 500,000. | 1 to 200,000. | 1 to 100,000. | 1 to 50,000. | 1 to 20,000. | 1 to 10,000. | 1 to 5,000. | 1 to 2,000. | 1 to 1,000. | 1 to 500. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | + | + | + | + | + | + | — | + | — | — |
| 5 00 | + | + | + | + | + | + | + | + | — | — |
| 7 30 | + | + | + | + | + | + | + | [b]+ | — | — |
| 10 00 | + | + | + | + | + | + | + | + | — | — |
| 12 30 | + | + | + | + | + | + | + | + | — | — |
| 15 00 | + | + | + | + | + | + | + | [c]+ | — | — |

[a] The stock solution of lime sulphur employed had a density of 32° Beaumé.
[b] Tube tested for *P. citri*, February 11; positive, February 13.
[c] Tube tested for *P. citri*, February 9; positive, February 11.

Two preliminary tests were necessary with this fungicide in order to obtain the limits of its action against the canker bacteria. Table 6 gives the results of the third test. Two later tests to define more closely the action of lime-sulphur solution were not in close agreement. The fourth test showed a dilution of 1 to 1,500 killing the canker bacteria at all exposures, while the 1 to 1,750 gave such results only in the longer exposures of 12½ and 15 minutes. The fifth test showed dilutions of 1 to 1,250 and 1 to 1,500 to be positive at all periods of exposure; 1 to 1,000 was negative at all periods of exposure. It seems safe to regard a dilution of 1 to 1,000 lime sulphur as sufficiently strong to kill the canker bacteria in the absence of organic matter.

The use of lime sulphur in orchard practice is especially desirable, of course, because of its additional value against citrus scab, wither tip, and insects. It would seem much more desirable than formalin; the latter has been used extensively against canker in the past, and its use hardly seems warranted by these tests and the writer's field experience.

TABLE 7.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of copper sulphate.*

[Date of test, February 8, 1920; date of observation, February 5, 1920.]

| Exposure. | Dilution. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 to 50,000. | 1 to 20,000. | 1 to 10,000. | 1 to 5,000. | 1 to 2,000. | 1 to 1,000. | 1 to 500. | 1 to 200. | 1 to 100. | 1 to 50. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | + | + | + | + | + | [a]+ | [a]+ | — | — | — |
| 5 00 | + | + | + | + | — | — | — | — | — | — |
| 7 30 | + | + | + | — | — | — | [b]— | — | — | — |
| 10 00 | + | + | + | [b]— | — | — | — | — | — | — |
| 12 30 | + | + | + | — | — | — | — | — | — | — |
| 15 00 | + | + | + | — | — | — | — | — | — | — |

[a] Tube tested for *P. citri*, February 5, 1920; positive, February 7, 1920.
[b] Tube tested for *P. citri*, February 5, 1920; negative, February 7, 1920.

The results with copper sulphate at more finely graduated dilutions could not be made to agree. In the five tests employed a dilution of 1 to 200 gave negative results at all lengths of exposure. A dilution of 1 to 500 was toxic to the canker bacteria at 2½ minutes exposure in only one test. Exposures of 5, 7½, 10, 12½, and 15 minutes at the same dilution were negative in all tests. The dilutions of 1 to 1,000 and 1 to 2,000 were positive in all tests at 2½ minutes, but varied for exposures of 5, 7½, 10, 12½, and 15 minutes. One to 5,000 was positive at all exposures in all tests. In view of the considerable variation in results for the five tests it is not safe to consider any dilution of copper sulphate above 1 to 200 or 1 to 300 as a disinfectant for *Pseudomonas citri*. This is of interest in view of the probable weak dilutions of copper salts which are made available by the weathering of Bordeaux mixture and other copper sprays upon trees, and seems to indicate that the toxic action of such copper sprays would have little value in preventing citrus-canker infection if dependent only on the soluble copper salts liberated upon the foliage.

Repetition of the tests with dilutions of Bordeaux 4–4–50 mixture was made eight times; the results show considerable variation in the bactericidal value of Bordeaux 4–4–50 mixtures. Tests were made which showed a killing action at as low a dilution as 5 per cent for a length of exposure of 5 minutes. More commonly, however, killing has only been obtained with the lesser dilutions of Bordeaux 4–4–50 mixture, and then usually only for the longer periods of exposure.

TABLE 8.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Bordeaux 4–4–50 mixture.*[a]

[Date of test, July 22, 1920; date of observation, July 25, 1920.]

| Exposure. | Dilution expressed in percentage. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. | 80. | 90. | 100. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | + | + | + | + | + | + | + | + | + | + |
| 5 00 | + | + | + | + | + | + | + | + | + | + |
| 7 30 | + | + | + | + | + | + | + | + | [b]+ | — |
| 10 00 | + | + | + | + | + | + | [b]+ | — | — | — |
| 12 30 | + | + | + | + | + | + | — | — | — | — |
| 15 00 | + | + | + | + | + | [b]+ | — | [c]— | [c]— | — |

[a] Bordeaux 4–4–50 mixture was prepared as nearly as possible as it is done in the field. Commercial quicklime and copper sulphate were used. In order to avoid contamination of the tests, however, autoclaved tap water was used in making up the mixtures.

[b] Tube tested for *P. citri*, July 24, 1920; positive, July 26, 1920.

[c] Tube tested for *P. citri*, July 24, 1920; negative, July 26, 1920.

Apparently the degree of impurities in the commercial lime and copper sulphate varies greatly and such variations are repeated in the toxic action of the Bordeaux mixture. In the eight tests made, Bordeaux 4–4–50 mixture, undiluted, at exposures of 15 or 20 minutes, resulted in the entire killing out of *Pseudomonas citri*. The tests indicate that in orchard practice the Bordeaux mixtures are far from being uniform in content and in bactericidal action.

For orchard use against citrus canker this mixture has an advantage over the disinfectants previously listed, in that it adheres to the foliage even in the most violent rains, and presumably affords some degree of bactericidal action as long as any of it is present on the leaf. Field tests in the Philippines and in Japan, as yet unpublished, support this statement. Bordeaux 4–4–50 mixture would therefore seem to be more desirable than the other germicides previously listed for use as a disinfectant spray in the eradication of citrus canker. Sterling[4] makes a similar statement of the action of Bordeaux mixture in Florida as follows:

> We have also noticed that where groves have been repeatedly sprayed with Bordeaux, even tho they are close to an affected grove, the chance of their becoming affected is considerably lessened, altho the Bordeaux does no good after the tree is once infected.

[4] Sterling, Frank, Eradication of citrus canker, Bull. Fla. Agr. Exp. Station 124 (1914) 53.

Sterling's observation would therefore seem to support the conclusion brought forward here; that is, that a spray of Bordeaux 4–4–50 mixture, because of its more lasting bactericidal properties in addition to its immediate killing capacity, is more valuable than a disinfectant which is washed off by the first rain or is evaporated soon after application.

In spraying tests in the field it had been suggested that the so-called neutral Bordeaux mixture might prove of greater value than Bordeaux 4–4–50 mixture. The term neutral Bordeaux mixture was used for a mixture in which the amount of lime added was just sufficient to precipitate all of the copper, with no excess. The reasoning followed in this suggestion apparently was that with an excess of lime, soluble copper salts would be available only after long weathering; with just the proper amount of lime to precipitate the copper entirely, with no excess, it seemed to follow that the soluble copper salts would be liberated more freely. Tests in the field with such a neutral Bordeaux mixture showed no advantage whatsoever over the Bordeaux 4–4–50 mixture; on the contrary, in the two-year trials in which the two mixtures were compared, a very slight advantage lay with the Bordeaux 4–4–50 mixture. Tests to compare the two mixtures by Anderson and McClintic's method were therefore made. The results are best shown in Table 9.

TABLE 9.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of neutral Bordeaux mixture.*[a]

[Date of test, August 13, 1920; date of observation, August 16, 1920.]

| Exposure. | Dilution expressed in percentage. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. | 80. | 90. | 100. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | [b]+ | + | + | + | + | + | + | + | + | [b]+ |
| 5 00 | + | + | + | + | + | + | + | + | + | + |
| 7 30 | + | + | + | + | + | + | + | + | + | + |
| 10 00 | + | + | + | + | + | + | + | + | + | + |
| 12 30 | + | + | + | + | + | + | + | + | + | + |
| 15 00 | + | + | + | + | + | + | + | + | [b]+ | [b]+ |

[a] The neutral Bordeaux mixture was made up with autoclaved tap water to avoid contamination; otherwise the preparation was entirely similar to the mixtures as prepared in the field. The neutral point was determined as nearly as possible by litmus paper tests.

[b] Exposure tested for *P. citri*, August 16; positive, August 18.

Tests with this mixture were repeated seven times; four of the tests resulted entirely uniformly with no killing of the canker bacteria whatsoever. The other three showed killing at the stronger dilutions for the longer periods of exposure. It seems probable, in the light of later tests, that killing was due, not to the copper compounds, but to a slight excess of lime resulting from an imperfect manufacture of "neutral" Bordeaux mixture. In any event the tests show that neutral Bordeaux mixture had little or no toxic action against the citrus-canker bacteria, in contrast to a more pronounced action exhibited by Bordeaux 4–4–50 mixture. Following out the suggestion from this, Bordeaux 4–6–50 mixture was tested. The results are presented in Table 10.

TABLE 10.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of Bordeaux 4–6–50 mixture.*

[Date of test, July 24, 1920; date of observation, July 29, 1920.]

| Exposure. | | Dilution expressed in percentage. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10. | 20. | 30. | 40. | 50. | 60. | 70. | 80. | 90. | 100. |
| *Min.* | *sec.* | | | | | | | | | | |
| 2 | 30 | [a]+ | — | — | — | — | — | — | — | — | [b]— |
| 5 | 00 | — | — | — | — | — | — | — | — | — | [b]— |
| 7 | 30 | — | — | — | — | — | — | — | — | — | — |
| 10 | 00 | — | — | — | — | — | — | — | — | — | [b]— |
| 12 | 30 | — | — | — | — | — | — | — | — | — | — |
| 15 | 00 | — | — | — | — | — | — | — | — | — | — |

[a] Tested on potato, July 26; positive, July 29.

[b] Bouillon tested by inoculation with *P. citri*, July 26; positive, July 29. This shows that the medium was not toxic to the organism.

This test was made four times with closely agreeing results. The evidence in regard to Bordeaux mixtures, then, showed that neutral Bordeaux mixture was valueless as a toxic agent against *Pseudomonas citri;* that Bordeaux mixture 4–4–50 was of slightly stronger bactericidal action; and that Bordeaux 4–6–50 was much the strongest of the three preparations. It was believed at first that this was because of a different copper compound, formed in the presence of an excess of lime, from that formed by the use of lime sufficient to make only neutral Bordeaux mixture. Tables 11 and 12 yield evidence upon this hypothesis.

The results were entirely unexpected, but have been corroborated by frequent tests. Comparing the results with those obtained from copper sulphate it is apparent that of the two constituents of Bordeaux mixture, quicklime when freshly slaked has at least as great a bactericidal value as copper sulphate, if not a greater. According to these tests a 0.1 per cent solution of freshly slaked lime has a complete killing effect against *Pseudomonas citri* in 2½ minutes, in the absence of organic compounds. Copper sulphate under identical conditions required a 0.5 per cent solution to kill *Pseudomonas citri* entirely in 2½ minutes.

TABLE 11.—*Results of exposures with 3-day-old culture of Pseudomonas citri dilutions of a solution of commercial quicklime in water. Stock lime solution, 4 pounds to 50 gallons water.*

[Date of test, August 13, 1920; date of observation, August 16, 1920.]

| Exposure. | Dilution expressed in percentage. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10. | 20. | 30. | 40. | 50. | 60. | 70. | 80. | 90. | 100. |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | — | — | — | — | — | — | — | [a]— | — | — |
| 5 00 | — | — | — | — | — | — | — | — | — | — |
| 7 30 | — | — | — | — | — | — | — | — | — | — |
| 10 00 | — | — | — | — | — | — | — | — | — | — |
| 12 30 | — | — | — | — | — | — | — | — | — | — |
| 15 00 | — | — | — | — | [a]— | — | — | — | — | — |

[a] Exposure tested on potato, August 16; negative, August 18.

This test was repeated with more dilute solutions of lime, and the results are shown in Table 12.

TABLE 12.—*Results of exposures with 3-day-old culture of Pseudomonas citri in dilutions of a solution of commercial quicklime in water.*

[Date of test, September 3, 1920; date of observation, September 6, 1920.]

| Exposure. | Dilution expressed in percentage.[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 |
| *Min. sec.* | | | | | | | | | | |
| 2 30 | + | + | + | + | + | + | + | + | — | — |
| 5 00 | + | + | + | + | + | + | + | — | — | — |
| 7 30 | + | + | + | + | + | — | — | — | — | — |
| 10 00 | + | + | + | + | — | — | — | — | — | — |
| 12 30 | + | + | + | — | — | — | — | — | — | — |
| 15 00 | + | + | + | — | — | — | — | — | — | — |

[a] Percentages express the weight of quicklime in volume of water.

A number of tests with Burgundy mixture[5] were also made. Burgundy 3–3–50 mixture, in which sodium carbonate is very slightly in excess of the amount necessary to precipitate the

[5] Burgundy mixture is prepared by precipitating the copper from a copper sulphate solution with sodium carbonate.

copper, in most of the tests showed no bactericidal value whatsoever. In a few tests slight killing was effected with the undiluted mixture at the longer exposures. When the results with the Bordeaux mixtures made it apparent that it was excess of lime which contributed the bactericidal value, the Burgundy mixture was prepared with an excess of sodium carbonate. In a comparative test, Burgundy mixture 3–4–50 showed a stronger toxic action against *Pseudomonas citri* than did Burgundy mixture 3–3–50. The toxic action was far from being as complete as in the case of Bordeaux mixture 4–6–50, or even Bordeaux mixture 4–4–50.

A comparison of these results with copper sprays and with lime leads to the conclusion that in none of the copper precipitate sprays, where there is no excess of either of the precipitants, is there any bactericidal action. This of course, on retrospection, was to be expected from a fungicide which consists of an insoluble precipitate in suspension.

The criticism of the value of these tests will be raised, that the fungicidal value of copper precipitate sprays depends upon the action of the products of metabolism of the fungus itself on the copper precipitate; these metabolism products liberate the copper in a soluble form which is then toxic to the fungus. It will be said then that, although the bacteria are not instantly killed in the foregoing copper precipitate tests, upon the tree their metabolism products will also liberate the copper from the copper precipitate as do the fungi, and that the bacterial cells would then be coagulated.

To prove or disprove this, organisms from a 3-day-old *Pseudomonas citri* culture were exposed to neutral Bordeaux mixture for 60 minutes. At the end of the exposure *P. citri* was easily recovered. *P. citri* from a 3-day-old culture was then inoculated into bouillon tubes containing .05 cubic centimeter of neutral Bordeaux mixture to 10 cubic centimeters of bouillon. Growth appeared as rapidly in the presence of the Bordeaux mixture as in the control tubes containing no *P. citri;* a copious ring characteristic of *P. citri* in vigorous cultures formed at the surfaces of all bouillon tubes, both in those containing neutral Bordeaux mixture and in the controls. The tests were repeated a number of times.

This is taken as showing that the metabolism products of *Pseudomonas citri* do not cause the liberation of copper from the copper precipitate formed in Bordeaux mixture, at least not in amounts sufficient to prevent or even check growth. Further work is now being carried on upon this subject.

## DISCUSSION OF RESULTS

A 1 to 100 solution of phenol, in the absence of organic substances, is entirely effective against *Pseudomonas citri* at an exposure of 2½ minutes. Mercuric bichloride at a dilution of 1 to 20,000 under the same conditions is also effective against *P. citri* at an exposure of 2½ minutes; *Liquor cresolis compositus,* at an exposure of the same length, will kill in a 1 to 300 solution; formalin, to kill under the same conditions, requires a 1 to 20 solution; an emulsion composed of *Liquor cresolis compositus* and kerosene is safely effective in a 1 to 50 dilution. Of the commercially used fungicides lime sulphur is effective at a dilution of 1 to 1,000 for an exposure of 2½ minutes; copper sulphate is a safe bactericide only at a dilution of 1 to 200 for the same length of exposure; neutral Bordeaux mixture has no bactericidal effect whatsoever even at exposures of 30 and 60 minutes; Bordeaux 4–4–50 mixture, undiluted, is not a safe bactericide against *P. citri* at an exposure of 2½ minutes, but at 15 minutes' exposure it was effective against *P. citri* in nearly all of the tests; Bordeaux mixture 4–6–50, a mixture in which the lime was considerably in excess, showed toxic action in 2½ minutes when diluted with 4 parts of water; unslaked lime (commercial) at a dilution of 1 to 1,000 was effective against *P. citri* for the same length of exposure. Burgundy mixture 3–3–50 was entirely effective against *P. citri,* and Burgundy 3–4–50 mixture showed toxic action only at the longer exposures, even when undiluted.

The application of these results in the orchard should be somewhat as follows: For disinfection of clothing, implements, etc., in canker-eradication work, mercuric bichloride as used, at a dilution of 1 to 2,000, is the most effective and, probably, under most conditions is the cheapest. In eradication work the occasion sometimes arises where, an infected tree being found and burned, it is desirable to spray the surrounding trees to kill any of the canker organisms which may exist on the surfaces of their foliage. In such cases formalin 1 to 100 has frequently been used in the past. The use of formalin 1 to 100 was recommended by Kellerman [6] in the Yearbook of the United States Department of Agriculture. According to these tests formalin

[6] Kellerman, K. F., Cooperative work for eradicating citrus canker, Yearbook U. S. Dept. Agr. for 1916 (1917) 270.

1 to 100 is entirely valueless, and spraying with such a solution might even serve to disseminate the canker bacteria and spread the disease. The present results would indicate that formalin, to be of any value, would have to be at a concentration of 1 to 20. The use of formalin at a dilution of 1 to 20, or even 1 to 40 or 1 to 60, is impossible on citrus trees, in as much as formalin at such dilutions burns the foliage. Mercuric bichloride at a dilution of 1 to 2,000 has also been known to burn the foliage of citrus trees. It would seem desirable, therefore, to use mercuric bichloride at a dilution of 1 to 5,000 or 1 to 10,000. Such dilutions, as shown by these tests, are effective as bactericides against *Pseudomonas citri.* Commercial unslaked lime at a dilution of 1 to 500, as shown by these tests, would be effective against the canker bacteria; would have a more lasting effect than such disinfectants as lysol, formalin, etc.; and would be cheap and entirely safe for use on citrus trees.

In orchard practice in countries where citrus canker is already generally prevalent and where spraying may be employed as an annual preventive measure, it may be desirable to combine such spraying measures with preventive measures against other diseases or insects. In such a case if a fungicide only is used, Bordeaux 4–6–50 would seem to be the only mixture having, at the same time, a proven fungicidal value and a bactericidal action against *Pseudomonas citri.* It has already been shown in field experiments not yet published that Bordeaux mixture 4–4–50 is more effective against citrus canker than neutral Bordeaux mixture. These field data in a way corroborate the present data in indicating that Bordeaux 4–6–50 would be the most effective Bordeaux mixture for use against citrus canker.

In case a contact insecticide were desirable at the same time as a spray against citrus canker, lime sulphur, as shown by the foregoing tests, would be effective at any of the dilutions desirable for insecticidal use.

The tests presented here suggest many possibilities in connection with citrus-canker control by spraying. It is very evident that the bactericidal action exhibited by Bordeaux and by Burgundy mixtures as used in orchard and field work is due to the excess of the negative ion rather than to the copper. It was shown in the tests with copper sulphate that as strong a concentration as 1 to 200 was necessary to exert any effect upon *P. citri* in 2½ minutes. Consideration of the conditions incident to the weathering of Bordeaux mixture on the foliage leads to the conclusion that rarely or not at all will such a concentration of 1 to 200 or even 1 to 500 be attained in the driving rains and dripping dews of citrus-growing countries. Field experiments with neutral Bordeaux mixture entirely agree with this. It would seem logical from these tests to expect a lime solution, at a dilution of 1 to 500, to be the cheapest and most effective spray, in orchard practice, against citrus canker.

In the absence of previous tests of the action of Bordeaux and Burgundy mixtures on bacterial plant pathogens, the foregoing tests are of interest and may be an index of the action of copper sprays against such other bacterial pathogens. It is unproved, however, since *Pseudomonas citri* may react to copper sprays differently from other bacterial plant pathogens.

## SUMMARY

1. At exposures of 2½ minutes, phenol will kill *Pseudomonas citri* in a 3-day-old culture when used in a 1 to 100 solution; mercuric bichloride under the same conditions requires a 1 to 20,000 solution; *Liquor cresolis compositus* requires a 1 to 300 solution; formalin, a 1 to 20 solution.

2. Of the commercially used spray mixtures, an emulsion of *Liquor cresolis compositus* and kerosene in 2½ minutes is entirely toxic to *Pseudomonas citri* at a dilution of 1 to 50; lime sulphur, 32° Beaumé, requires a 1 to 1,000 solution; copper sulphate, a 1 to 200 solution; neutral Bordeaux mixture has no bactericidal value whatsoever; Bordeaux 4–4–50 mixture is of doubtful bactericidal value even when undiluted; Bordeaux 4–6–50 mixture at 2½ minutes' exposure is a safe bactericide even when diluted with 4 parts of water; lime when slaked is effective against *Pseudomonas citri* when diluted to a 1 to 1,000 solution.

3. Burgundy 3–3–50 mixture and Burgundy 3–4–50 mixture have little or no bactericidal value against *Pseudomonas citri* even at the longer exposures.

4. The use of formalin as a spray for the soil or the tree, or as a disinfectant, would seem to be uneconomical and in many cases entirely without value, except in a few remote instances where it might possibly be desirable partially to defoliate affected trees.

5. The definite conclusion is put forward that copper precipitate sprays as bactericides against *Pseudomonas citri* are entirely valueless unless the lime is added in excess. The toxicity of such a spray then is of more or less value in proportion to the quantity

of quicklime added in excess, and is apparently dependent upon the concentration of calcium hydroxide in the solution. A lime solution is suggested for field trial against *P. citri.*

6. The foregoing tests may possibly be an index of the action of copper sprays against bacterial plant pathogens other than *Pseudomonas citri,* although of course *P. citri* may exhibit a peculiarity in its reaction to copper sprays different from the action of other bacterial pathogens.

173259——2

# NEW REARED PARASITIC HYMENOPTERA FROM THE PHILIPPINES

By A. B. Gahan

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The writer has recently had opportunity to study several series of reared parasitic wasps received by the Bureau of Entomology from the Philippine Islands. Six species have been found to be new to science and are described in the following pages. Because of the definite host records, this material is especially interesting and valuable. Two of the new species were sent in by Prof. C. F. Baker, while the others were all received from Prof. Charles S. Banks, at the time chief of the department of entomology of the College of Agriculture, at Los Baños. Two new species are said to be parasitic upon scale insects, two species were reared from the eggs of a hemipteran, one species is parasitic upon a leaf-mining buprestid, and one species issued from cocoons of a gracillarid moth.

## Superfamily CHALCIDOIDEA

### ENCYRTIDÆ

**Homalotylus mundus** sp. nov.

Very similar in appearance to *H. albitarsis* Gahan, but easily distinguished by the fact that the vertex is narrower, the legs are slightly differently colored, and the ovipositor is distinctly longer.

*Female.*—Length, 1.5 millimeters. Vertex, frons, and face granularly opaque; head behind the eyes faintly lineolate and more or less shining; vertex very narrow, at its narrowest point less than the length of pedicel; antennal scape long and slender; pedicel nearly three times as long as thick and distinctly longer than first funicle joint; first funicle joint approximately one and one-half times as long as thick, second slightly longer than thick; following joints subquadrate; club not thicker than the funicle and about as long as three preceding funicle joints combined, pointed at apex; pronotum and mesoscutum scaly punctate, slightly shining; axillæ and scutellum granularly opaque; propodeum very faintly shagreened and shining; mesopleura lineolate-reticulate, subopaque; legs long, the posterior femora and tibiæ strongly compressed; middle tibial spur slender and somewhat longer than metatarsus; abdomen shorter than thorax and slightly narrower, rather strongly sculptured dorsally; ovipositor exserted about half the length of abdomen. Head, prothorax beneath, axillæ, and scutellum pale orange yellow; pronotum dorsally, mesoscutum, metathorax, propodeum, and abdomen brownish black, the propodeum and abdomen tinged with bluish; antennal scape, pedicel, and first three funicle joints blackish; funicle joints beyond the third, and the club white; tegulæ whitish basally, apical half brownish; prefectus mostly pallid; forewings subhyaline at base and apex with a broad fuscous cloud across the middle, and with a distinct narrow hairless line from the base of stigmal vein nearly to the posterior margin of wing; mesopleura, all coxæ, posterior femora above, and hind tibiæ dark brown or blackish; anterior and median femora and tibiæ, and a marginal stripe on posterior femora beneath pale testaceous; all tarsi pallid.

*Male.*—Agrees in every way with the description of the female.

*Type locality.*—LUZON, Laguna Province, Los Baños.

*Type.*—Catalogue No. 22344, United States National Museum.

*Host.*—*Pseudococcus virgatus* Cockerell.

Described from 15 specimens, 8 females and 7 males, received from Prof. C. F. Baker, by whom they were reared from the above-named coccid.

The color of this species is somewhat variable. The antennæ are not infrequently entirely white beyond the first funicle joint; legs are frequently stained with brownish, and the mesopleura vary from about the color of the mesoscutellum to nearly black.

**Taftia saissetiæ** sp. nov.

This species is extremely close to *T. prodeniæ* Ashmead, but is somewhat darker in color and differs also by having the funicle joints of the female antennæ distinctly compressed, those beyond the first obliquely truncate at apex and dorsally overlapping the base of the following joint; joints 3 to 6 of the funicle, viewed laterally, all distinctly broader than long and successively broader toward the club, the sixth twice as broad as long. In *prodeniæ* the funicle joints are more nearly cylindrical and all except the last are slightly longer than broad with the apical truncation squarely transverse. The males can be distinguished from those of *prodeniæ* only by the fact that the form is slightly more robust, the propodeum mesad of the spiracle is opaque, and the face is dark green instead of strongly purplish.

*Female.*—Length, 1.6 millimeters. Head, pronotum, mesoscutum, axillæ, and scutellum opaquely punctate, the sculpture of scutellum very finely granular; mesopleura nearly smooth; metapleura and propodeum subopaque; abdomen as broad and about as long as the thorax, subtriangular, the dorsum weakly shagreened. General color very dark brown, the thorax above and the abdomen nearly black; propodeum and to some extent the sides of pronotum and the metapleura dark reddish testaceous; scape, pedicel, and funicle dark reddish testaceous, the funicle shading into dark brown toward apex and with the sutures between joints brown; club nearly black; legs concolorous with scape; their tibiæ somewhat darker; wings from beyond the middle of submarginal vein to apex faintly infuscated, the infuscation strongest along the submarginal vein basad of the marginal vein.

*Male.*—Length, 1.2 millimeters. Less-strongly sculptured than the female; viewed from in front, the head within the antennal depression weakly sculptured and more or less shining; frons and vertex opaquely punctate, with a few larger scattered punctures; antennal flagellum subcylindrical, very slightly compressed, the funicle joints subquadrate, club elongate-ovate, about as long as the two preceding funicle joints and scarcely broader than the funicle; abdomen very short, semicircular or subtriangular in outline and not much longer than the scutellum. Head, thorax, and abdomen black; scape and pedicel pale testaceous beneath, more or less brownish above; funicle and club black; coxæ concolorous with thorax; all femora and tibiæ brownish testaceous, the tarsi pale testaceous; wings subhyaline.

*Type locality.*—LUZON, Laguna Province, Los Baños.

*Type.*—Catalogue No. 22343, United States National Museum.

*Host.*—*Saissetia hemisphærica* Targioni.

Four females and 2 males, received from Prof. C. F. Baker, bearing his Nos. 11562 and 11563.

## PTEROMALIDÆ

**Acroclisoides luzonensis** sp. nov.

Agrees with the characterization of the genus by Girault.[1]

*Male.*—Length, 1.6 millimeters. Head very broad, much

[1] Mem. Queensland Mus. 3 (1915) 334.

broader than the thorax, viewed from in front nearly one and three-fourths times as broad as long; ocellocular line nearly twice as long as the postocellar line; whole head strongly reticulate-punctate, the mouth region not striated; clypeus separated from the face by a very indistinct groove which is darker than the rest of the face; the anterior margin of clypeus triarcuately emarginate, the emarginations not deep; mandibles very large, 4-dentate; malar space at base of mandibles deeply concave; antennæ inserted above the middle of the face; scape reaching a little beyond the posterior ocelli; pedicel nearly globular; two transverse ring joints; funicle 6-jointed, the first joint approximately twice as long as the pedicel, the following funicle joints gradually decreasing in length, the sixth nearly twice longer than broad; club 3-jointed, slightly longer than the two preceding funicle joints; pronotum short, transverse, a little narrower than the mesoscutum, punctate, its posterior margin narrowly shining and impunctate; mesoscutum and scutellum sculptured like the head, the mesoscutum nearly twice as broad as long, with distinct complete parapsidal grooves; axillæ shining, with faintly reticulate sculpture; propodeum medially sculptured like the scutellum, with a very distinct median carina, the lateral folds represented by a large round fovea at base on either side of the middle, the spiracular sulci very deep, the surface of the propodeum on either side of the spiracular sulcus smooth and polished; neck of propodeum short; marginal vein of forewing distinctly though not greatly thickened; stigmal vein slightly shorter than the marginal and with a rather large knob; postmarginal very slender and somewhat longer than the marginal; abdomen approximately as long as thorax, spatulate in outline; petiole short, slender, and polished, much shorter than the hind coxæ; following tergites all smooth and polished, the second triangular and constituting about one-third the length of the abdomen; third and fourth together about equal in length to the second; those beyond the fourth very short. Head, thorax, and all coxæ bright aëneous; apex of hind coxæ more or less testaceous; abdomen brownish black with more or less bluish metallic reflections; flagellum brownish black; antennal scape, pedicel, and all of legs except their coxæ, pale reddish testaceous; wings hyaline.

*Type locality.*—LUZON, Laguna Province, Los Baños.

*Type.*—Catalogue No. 22348, United States National Museum.

*Host.*—*Tectocoris lineola* Fabricius.

Described from 3 males, received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines; accession No. 18474; reared, June 24 to 27, 1918.

Professor Banks states that the parasite cuts a large sickle-shaped opening in the top of the egg when emerging, and that the larva devours less than half of the contents of the egg. There is but one parasite to the egg.

This species was reared from the same clutch of eggs as *Aphanurus banksi,* described in this paper, and may be a parasite of the *Aphanurus.*

## ELASMIDÆ

**Elasmus albomaculatus** sp. nov.

*Female.*—Length, 2.3 millimeters. Antennal scape slender, pedicel shorter than the first funicle joint; funicle joints subequal, cylindrical, the first very slightly the longest, third joint approximately twice as long as thick; club about as long as joints two and three of the funicle combined; vertex and frons with large scattered punctures; pronotum and mesoscutum rather strongly scaly-punctate, each puncture with a dark hair; scutellum very faintly reticulately sculptured, nearly smooth; metanotum triangular, projecting posteriorly over the propodeum; propodeum faintly sculptured like the scutellum, without carinæ; pleura and hind coxæ laterally finely lineolate; middle femora with a single long stiff bristle on the inner side at apex; hind tibiæ posteriorly with rows of hairs arranged in distinct, diamond-shaped figures; hairs on basal joint of middle and hind tarsi in distinct rows; wings long and rather narrow, extending to apex of abdomen; abdomen somewhat longer than the head and the thorax combined. Head and mesoscutum dull blue-green; antennal flagellum brown, scape pale yellow; scutellum black, very slightly metallic; narrow line at base of tegulæ, small marginal spot on mesoscutum just above tegulæ and the triangular metanotum yellowish white, the latter with a hyaline border; propodeum dull bronze; rest of thorax, abdomen, all coxæ and all femora, except anterior pair at apex, shining black. Apices of front femora and all tibiæ whitish; tarsi mostly dark; hairs on legs black; wings hyaline.

The species is very similar to *E. elegans* Crawford, but differs in having the abdomen and all coxæ black, and in the presence of the white spot before the tegulæ. Differs from *E. philippinensis* Ashmead in having much longer funicle joints, as well as in color.

*Type locality.*—LUZON, Manila.

*Type.*—Catalogue No. 22347, United States National Museum.

*Host.*—*Acrocercops* sp.

Described from 2 female specimens, received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines, accession No. 18477. Professor Banks bred the specimens from the cocoons of a moth the larva of which feeds on *Cæsalpinia pulcherrima* (L.) Sw. The moth, specimens of which were received along with the parasite, has been determined by Mr. August Busck as *Acrocercops* sp., a gracillarid.

## EULOPHIDÆ

**Pleurotropis anomala** sp. nov.

While a typical *Pleurotropis* in every other respect, this species differs markedly from any other species known to the writer in the conformation of the mesoscutum.

*Female.*—Length, 1.5 millimeters. Head viewed from in front smooth and polished above the transverse groove; vertex divided by a distinct, shallow groove running from the anterior ocellus posteriorly to the occipital carinæ; between the transverse groove and base of antennæ reticulated and subopaque; below the antennæ smooth and polished; eyes with their medial margins slightly emarginate; posterior orbits very narrow; antennæ inserted near clypeus; scape slightly fusiform; pedicel pyriform, approximately one-third as long as scape and slightly shorter than the first funicle joint; funicle 3-jointed, the joints subequal and all distinctly shortly pedicellate at apex; club conic-ovate, about one and one-half times the length of third funicle joint, 2-jointed, the second joint terminating in a distinct spine; dorsal portion of pronotum polished and delicately margined anteriorly, the declivitous portion sculptured; mesoscutum with a straight, deep, transverse fold across the middle connecting the parapsidal grooves; behind this fold and extending to the posterior margin of the mesoscutum a deep, broad, rectangular depression divided by a median longitudinal ridge and homologous with the two shallow foveæ at the posterior end of the parapsidal grooves found in other species of the genus; depressed area of the mesoscutum perfectly smooth, remainder of mesoscutum and the scutellum delicately reticulate, interstices rather large and polished, those at base of scutellum longitudinally elongate and the median base of scutellum with a small area which is not reticulated; axillæ polished; propodeum polished and with delicate carinæ, the two median carinæ rather strongly diverging posteriorly; wing veins rather slender, stigmal knob small, postmarginal very delicate and indistinct; abdomen a little longer than the head and thorax combined; first segment (petiole) about as broad as long, opaquely shagreened, and weakly margined laterally; second tergite constituting more than half the length of abdomen; above smooth and polished on basal two-thirds, the apical third delicately reticulated; beneath finely, longitudinally striated; tergites beyond the first short, subequal, very faintly sculptured. Sculptured portion of face blackish; antennæ blackish with metallic reflections; frons, vertex, pronotum dorsally, mesoscutum, scutellum, propodeum dorsally, and unsculptured portion of second abdominal segment highly metallic blue-green; thorax laterally and beneath and the legs bluish black with metallic reflections; abdomen beyond the apical third of second tergite and beneath, black; narrow apex of tibiæ and basal three joints of all tarsi whitish; two apical tarsal joints blackish; wings hyaline.

*Male.*—Length, 1.2 millimeters. Antennæ missing. Like the female except that the head is entirely metallic green, the sides of thorax are more strongly bluish, the abdomen is scarcely as long as thorax, its petiole distinctly longer than broad; the second tergite occupies most of the dorsal surface of abdomen and is not so distinctly striated beneath, and only the apical tarsal joint is black.

*Type locality.*—LUZON, Laguna Province, Los Baños.

*Type.*—Catalogue No. 22345, United States National Museum.

*Host.*—*Endelus bakeri* Kerremans.

Type, allotype, and female paratype, and the head of a third female received from Prof. Charles S. Banks, of the College of Agriculture, University of the Philippines, accession No. 18394. Reared on February 25, 1918, from the above-named leaf-mining buprestid. Antennæ from female paratype mounted on a slide.

## Superfamily SERPHIDOIDEA

### SCELIONIDÆ

**Aphanurus banksi sp. nov.**

This species runs straight to the genus *Aphanurus* in J. J. Kieffer's key to the genera of Telenominæ [2] and agrees with the description of the genus.

[2] André Spéc. Hym. Eur. Alg. 11 (1912) 7.

*Female.*—Length, 1.5 millimeters. Head strongly transverse, as broad as the thorax, strongly rugose-punctate; ocelli touching the eye margin; front of head between base of antennæ and anterior ocellus with strong, transversely directed rugæ, except a small, nearly smooth area immediately in front of the ocellus; malar space with two strong, parallel carinæ running from the clypeus to the eye margin, and a third, weaker, subparallel carina behind these two; the middle carina continued as a sharp orbital carina narrowly separated from the eye margin and reaching to the vertex; eyes glabrous; antennal scape reaching to the front ocellus; pedicel slender, about twice as long as broad at apex; third antennal joint a little longer than the pedicel, fourth a little longer than broad and narrower at base than at apex; fifth transverse; club distinctly 6-jointed, the joints all slightly broader than long, except the last, which is a little longer than broad; thorax coarsely sculptured; mesoscutum posteriorly with coarse, irregular, longitudinal striation; scutellum coarsely rugose; propodeum very short, visible from above only laterally where it is rugosely sculptured, more or less concave behind, the concave posterior face bounded by a sharp carina; stigmal vein of front wing more than twice as long as the marginal, postmarginal nearly twice as long as the stigmal; abdomen about as long as thorax; first tergite strongly longitudinally striate, second tergite coarsely foveolate at base and with the basal three-fourths indistinctly striate, apical fourth of the second tergite and all of the short third tergite smooth, tergites beyond third concealed from above; second sternite extending nearly to apex of abdomen, coarsely foveolate at base, strongly longitudinally striate anteriorly and laterally, with the posterior middle area and the apex smooth and polished. Black; scape, pedicel, three basal joints of the flagellum and legs, except coxæ, reddish testaceous; wings hyaline.

*Male.*—Agrees with the female except that the antennæ are reddish testaceous, only the club slightly brownish; pedicel is scarcely longer than broad; the third antennal joint is approximately twice as long as pedicel, the fourth very slightly shorter than third, the fifth about one and one-half times as long as broad, the sixth very slightly longer than broad, the seventh to the tenth globular and shortly petiolate, the eleventh conical and one and one-half times as long as broad. The anterior carina as well as the posterior one on the malar space are weaker than in the female, only the median one being prominent.

*Type locality.*—LUZON, Laguna Province, Los Baños.

*Type.*—Catalogue No. 22346, United States National Museum.

*Host.*—*Tectocoris lineola* Fabricius.

Two females, 3 males, and 1 broken specimen, the sex of which cannot be determined, received from Prof. Charles S. Banks, under College of Agriculture, University of the Philippines, accession No. 18476; reared, July 5 to 23, 1918, from the eggs of *Tectocoris lineola* Fabricius.

# THE PSYLLIDÆ OF BORNEO

By D. L. Crawford
*Of the College of Hawaii*

ONE PLATE

Our knowledge of the psyllid fauna of Borneo is fragmentary and far from complete, as only a few localities on this large island have been visited by collectors. The most extensive collections in the group have been made by Prof. C. F. Baker. Several interesting forms have been captured there by Mr. Frederick Muir also.

There is presented here a list of all the Bornean Psyllidæ known to me, together with descriptions of several new species.

## PAUROPSYLLINÆ

**Pauropsylla udei** Rübsaamen.

A species very widely distributed throughout the East Indies and tropical Asia. Two specimens collected at Sandakan, Borneo (*C. F. Baker*).

**Paurocephala psylloptera** Crawford.

A single female specimen taken at Sandakan, Borneo (*Baker*), probably belongs to this species, although it is a little smaller than the average Philippine specimen and has somewhat darker forewings. This is a widely distributed species in tropical Asia and Oceania and is, therefore, subject to some variation. *Agonoscena sauteri* Enderlein is a synonym of this.

**Macrohomotoma apsylloides** (Crawford).

*Pauropsylla apsylloides* Crawford.

This species was at first referred to the genus *Pauropsylla* with some hesitation, but subsequent comparisons indicate its very close relationship to *Macrohomotoma gladiatum* Kuwayama, a Formosan species. In wing venation and cephalic characters it is very similar to Kuwayama's species, but differs a little in the female genitalia, in the Formosan species the genital segment being comparatively shorter.

A male specimen was taken at Sandakan, Borneo (*Baker*). The following description of the male genitalia supplements the previous description of the species which lacked this: Forceps slender, moderately long, slightly clavate distad, not as long as height of anal valve; anal valve large, with a caudal projection about as long as height of anal valve.

The East African species of this genus (*M. nyasae* Newstead)[1] is remarkably similar in male and female genital characters but differs in minor wing venational features.

This genus appears certainly to be related to the Pauropsyllinæ instead of to the Carsidarinæ.

### Genus **TRIGONON** novum

Head much deflexed, short, without genal processes; vertex triangular, converging in front to a narrow point at front ocellus; genæ extending laterad somewhat beyond vertex. Antennæ very long and slender, as long as body to tip of folded wings or longer. Eyes very large, hemispherical. Thorax strongly arched, hirsute. Forewings more or less transparent, rounded at apex, veins setiferous; pterostigma present.

Type of the genus, *Heteropsylla longicornis* Crawford.

The most distinctive features of this genus are the triangular vertex and excessively long antennæ. Two species are included, both from the South Pacific.

**Trigonon pacificum sp. nov.** Plate 1, fig. 6.

Related to *T. longicornis* Crawf., a South Pacific species, but much larger.

Length of body (female), 4.4 millimeters; length from head to tip of folded wing, 5.7. General color brown, with a pale stripe down center of thoracic dorsum and two black stripes on each side of mid line.

Head short, broad, sparsely hirsute; vertex strongly concave, posterior ocelli elevated; frons visible around front ocellus and beneath it to labrum; genæ large, nearly meeting over frons at one point just beneath front ocellus, not produced into conical processes or lobes, except for a very small tubercle on each gena opposite the labrum. Antennæ very long and slender, as long as body to tip of folded wings.

Thorax rather broad, stout, sparsely hirsute. Legs short; hind tibiæ stout, with a small spur at base and several spines at apex. Forewing fumate or slightly browned but transparent, narrowly rounded at apex, veins with short setæ, costa thick

[1] Ent. News 25 (1914) 62–65.

and densely hairy; each apical cell of wing brownish near apical margin, with a clear spot in each at margin.

Female genital segment very long and acuminate, longer than rest of abdomen, acute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

**Diclidophlebia**[2] **oceanica** Crawford.

This very remarkable and apparently rare species was described from two specimens from the Philippines and one from Singapore. One specimen has been taken by C. F. Baker at Sandakan, Borneo, which is similar in all important respects and probably represents the same species. The Borneo specimen is a little larger, and the legs are somewhat more foliaceous. Wing venation differs only in minor characteristics. There are scarcely enough differences to warrant making a new species for the Borneo form.

**Tenaphalara juliana** Crawford.

An additional specimen (female) has been received from C. F. Baker. The female genital segment is moderately short, and stout at base; the apical one-third is abruptly narrowed and small, black in contrast to the orange color of the basal portion, acutely pointed.

The forelegs have a narrow black or brown stripe on inner side. Closely related to *T. malayensis*, but quite distinct from that species.

**Tyora ornata** (Kirkaldy).

*Nesiope ornata* KIRKALDY.

Walker's old genus *Tyora* has been misunderstood by subsequent students of this family, except by Scott who figured the species from Walker's type. *Tyora congrua*, Walker's type species, is not at all congeneric with certain Australian species referred to that genus, but appears to be identical with a South Pacific species described recently as *Carsidaroida heterocephala* Crawford and subsequently referred by me to Kirkaldy's genus *Nesiope*. In other words, *Nesiope* Kirkaldy, and hence *Carsidaroida* Crawford, become synonyms of *Tyora* Walker.

*Tyora* (*Nesiope*) *ornata* was first discovered in Fiji, but probably exists in other parts of the South Pacific, since it is now recorded from Borneo. One male was taken at Sandakan

[2] Diclidophlebia nom. nov. pro *Heteroneura* Crawford. The latter name is preoccupied in Diptera.

(*Baker*) which appears almost certainly to be identical with Kirkaldy's *Nesiope ornata*, of Fiji.

*Tyora hibisci* Froggatt and *T. indica* Crawford should be referred to *Mesohomotoma*, a genus erected in 1907 by Kuwayama for a species undoubtedly congeneric with the two mentioned above. *Udamostigma* was proposed by Enderlein in 1910 for Froggatt's *T. hibisci*, but *Mesohomotoma* has the right of priority.

### Genus **TRIOZA** Foerster

The genus *Trioza* is not abundantly represented in the Old World Tropics. The members of this genus have the hind tibiæ unspurred and the basal tarsus of the hind legs without apical clawlike spines; in the forewings the basal vein forks at one point into three veins. *Megatrioza* is a common genus in the Palæotropics, differing from *Trioza* chiefly in the armature of the hind tibiæ. It is a curious fact that several other palæotropical genera of Triozinæ have the hind tibiæ more or less armed as in *Megatrioza*.

Two closely allied but distinct species in Borneo have certain *Trioza* characters, but still are not typical members of that genus. Provisionally, however, they may be grouped in *Trioza*.

**Trioza insula** sp. nov. Plate 1, fig. 2.

Length of body, 2.3 millimeters (female); forewing, 3. General color light brown, eyes and part of vertex adjoining eyes black, a black spot on mesopleura. Head short in dorsal aspect, vertex smooth, without depressions, rounded foreward and down, in front extending down narrowly on each side and beyond front ocellus between bases of genal cones. Genal cones half as long as vertex, conical, subacute, divergent. Antennæ about twice as long as width of head, moderately stout.

Thorax smooth, surface reticulately marked. Hind tibiæ with a very small spur at base and three spines at apex. Forewing long and narrow, acutely pointed, hyaline, with a brown stripe along posterior margin from claval suture to apex; media and cubitus not forking from basal trunk at same point with radius; radius short. Hind wing a little more than half as long as forewing.

Female genital segment nearly as long as rest of abdomen, subacute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

**Trioza papillata** sp. nov. Plate 1, fig. 3.

Very obviously related to *T. insula* but quite different in several respects. Insect much smaller, body, about 1 millimeter long; forewing, 2 millimeters long. Vertex as in related form, extending forward in front of front cellus; genal cones small, fingerlike or nipplelike in shape, separate at base and slender, acute. Antennæ black, twice as long as width of head. Legs small and slender. Forewings similar to *T. insula* in shape and venation, but smaller and without brown band. Female genital segment about as long as rest of abdomen, acute at apex.

BORNEO, Sandakan (*Baker*), 1 female.

**Megatrioza asiatica** Crawford.

This tropical Asiatic species appears to be present in Borneo, being represented in C. F. Baker's collection by four specimens which closely resemble specimens from other regions. These were taken at Sandakan, Borneo.

**Megatrioza eugenioides** Crawford.

This species appears to be rather widely distributed in tropical Asiatic regions. Several additional specimens have been taken by Baker at Sandakan, Borneo.

**Megatrioza grandis** sp. nov. Plate 1, fig. 1.

Somewhat similar to *M. gigantea* Crawford, but longer and slenderer. Length from head to tip of folded wings, 8 millimeters or more. Orange to light brown, few or no markings on body; legs and antennæ concolorous, wings slightly fuscous.

Genal cones shorter than vertex, broad and rounded, sparsely hairy. Antennæ nearly twice as long as width of head, slender. Thorax long. Legs long, rather stout; hind tibiæ with large spur at base and three short spines at apex. Forewing very long, three times as long as broad, subacute at apex; upper fork of media terminating at wing tip; cubitus forked distad of mid-point. Hind wings about half as long as forewings.

Male forceps nearly as long as anal valve, slender, curved, with a fringe of hairs on posterior margin; anal valve broad, posterior margin bulging caudad, with a fringe of long hairs.

BORNEO, Sandakan (*Baker*), 1 male.

173259——3

**Leuronota attenuata** sp. nov. Plate 1, fig. 4.

Length of body, 2.2 millimeters; forewings, 4.0; length from head to tip of folded wings, 4.8. General color light brown with black irregular markings on thorax; forewings light brown, not transparent, thickly mottled with small black or brown spots.

Body narrow, long, dorsum not at all arched. Head porrect, vertex as long as broad, protruding forward in two short, blunt epiphyses; genal cones nearly as long as vertex, porrect, constricted at base, diverging, acute, hairy. Antennæ twice as long as width of head, slender.

Thorax with a sparse clothing of long hairs; tibiæ more densely hirsute; hind tibiæ with a spur at base and one long and three shorter spines at apex. Forewing opaque, long and narrow, acutely pointed at apex, strikingly mottled, veins setose. Hind wings nearly as long as forewings.

Male genitalia: Forceps about as long as anal valve, broad at apex, moderately stout; anal valve short, apex truncate, each side protruding a little caudad at apex.

BORNEO, Sandakan (*Baker*), 1 male.

**Leuronota microceras** (Crawford).

This was described as a *Cerotrioza* from one specimen taken in West Borneo (Mowong) by F. Muir. It is specifically quite distinct from the new species described above, but should be referred to the genus *Leuronota* instead of *Cerotrioza.*

**Arytaina pulchra** sp. nov. Plate 1, fig. 5.

Length of body, 2 millimeters; forewings, 2.5 millimeters. General color brownish; vertex, pronotum, and mesonotum light brown, the rest dark brown with irregular light markings and spots; forewings strikingly maculated with dark brown.

Head not strongly deflexed; vertex a little more than half as long as wide; genal cones nearly as long as vertex, divergent, porrect, subacute. Antennæ very long and slender, about as long as body to tip of forewings.

Thorax briefly pubescent. Legs slender, femora spotted with brown. Forewings broadest subapically, rather square at apex and narrowing toward base, transparent except on maculæ, veins spotted. Hind wings nearly as long as forewings. In shape of forewings this seems to resemble species of *Diaphorina,* but is distinct in other characters.

Female genital segment short, both valves acutely pointed.

BORNEO, Sandakan (*Baker*), 1 female.

**Arytaina variabilis** Crawford.

Probably this is a widely distributed species, as it has been found in the Philipines, Malay Peninsula, and now in Borneo, all by C. F. Baker. The dark band on the hind margin of the forewing makes this an easily recognized species.

**Psylla fumosa** Crawford.

Six more specimens of this species have been collected by Baker at Sandakan, Borneo, all closely resembling the type, and bearing the same similarity to the Philippine species, *P. crenata*.

## ILLUSTRATION

### PLATE 1

Forewings of Psyllidæ. (Stippled areas represent solid coloration of wing membrane.)

FIG. 1. *Megatrioza grandis* sp. nov.; original drawing, about × 25.

2. *Trioza insula* sp. nov.; original drawing, × 35.
3. *Trioza papillata* sp. nov.; original drawing, × 28.
4. *Leuronota attenuata* sp. nov.; original drawing, × 24.
5. *Arytaina pulchra* sp. nov.; original drawing, × 28.
6. *Trigonon pacificum* g. et sp. nov.; original drawing, × 28.

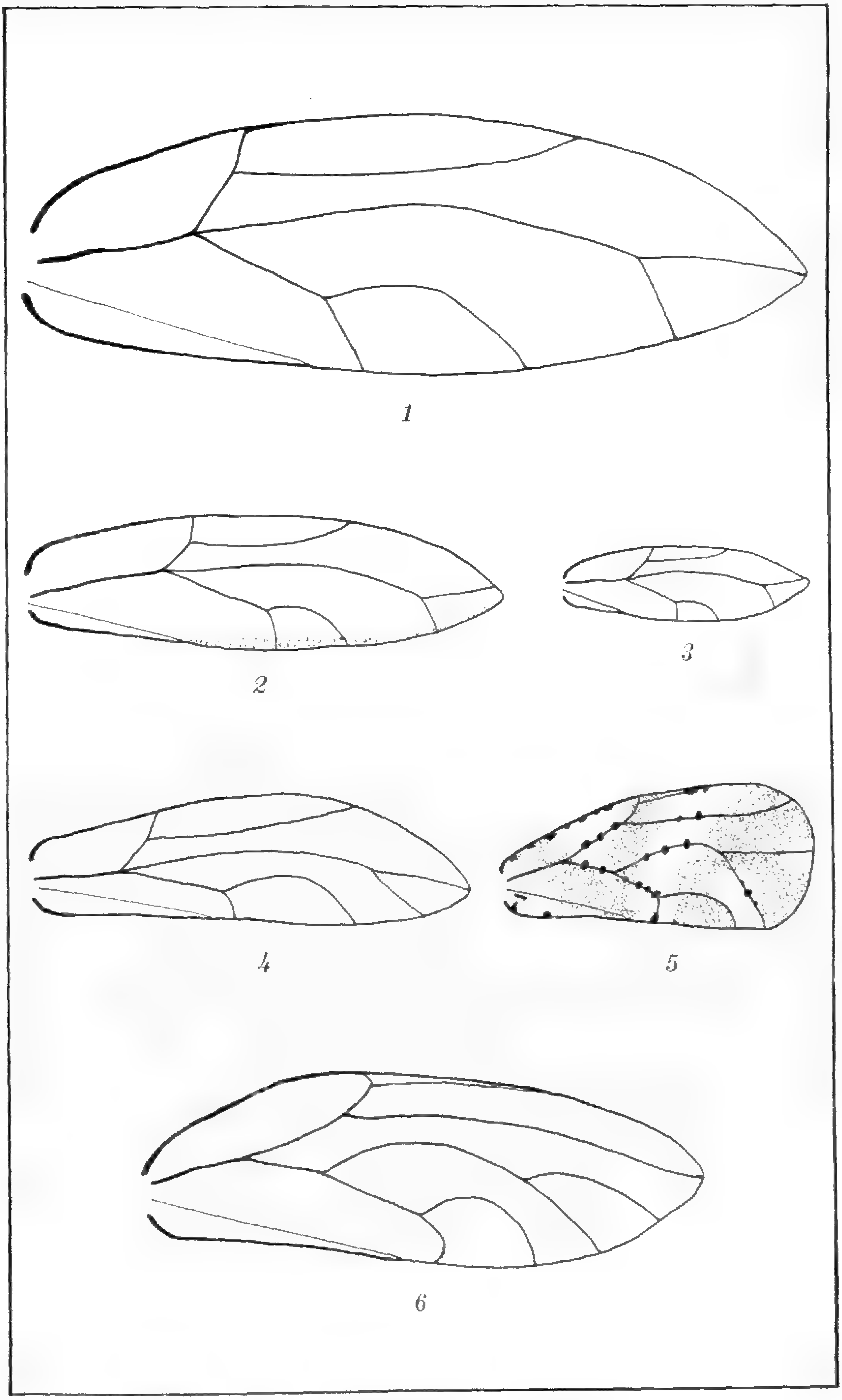


PLATE 1. FOREWINGS OF PSYLLIDÆ.

# HIGHER BASIDIOMYCETES FROM THE PHILIPPINES AND THEIR HOSTS, IV

By Otto A. Reinking

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The following list is a continuation of determinations of Philippine higher Basidiomycetes and wood-destroying fungi collected primarily on Mount Maquiling or in the vicinity of Los Baños, Laguna Province, Luzon. The collections have been made either by me or by my students under my direction. All identifications as herein given were made by N. Patouillard, of Neuilly-sur-Seine, France.

The species are grouped, in so far as possible, according to the classification of Engler and Prantl, with the host and the collector under each species of fungus. The numbers refer to the College of Agriculture fungus herbarium.

## AURICULARIACEAE

### AURICULARIA Bulliard

**AURICULARIA MESENTERICA** (Dicks.) Fr.

Annonaceae, Mount Maquiling, *Reinking 142,* on dead branches.

*Bassia betis* (Blanco) Merr., Mount Maquiling, *Cazeñas 1050,* on dead branches.

**AURICULARIA POLYTRICHA** (Mont.) Sacc.

*Annona muricata* Linn., Los Baños, *Reinking 3032,* on dead branches.

*Bixa orellana* Linn., Mount Maquiling, *Reinking 3121,* on dead branches.

*Canarium villosum* (Miq.) F.-Vill., Mount Maquiling, *Reinking 3097,* on dead branches.

*Cleidion javanicum* Blume, Mount Maquiling, *Reinking 3064, 3092,* on dead branches.

*Ficus angustissima* Merr., Mount Maquiling, Laguna, *Reinking 6463,* on dead branches.

*Koordersiodendron pinnatum* (Blanco) Merr., Mount Maquiling, *Reinking 3287,* on dead branches.

*Lagerstroemia speciosa* (Linn.) Pers., Mount Maquiling, *Reinking 4611,* on dead branches.

*Manihot utilissima* Pohl, Los Baños, *Morada 3201,* on dead stem.

*Solanum grandiflorum* Ruiz et Pav., Los Baños, *Reinking 3292,* on dead stems.

*Streblus asper* Lour., Mount Maquiling, *Reinking 3027,* on dead branches.

**AURICULARIA TENUIS** Lév.

*Euphorbia hypericifolia* Linn., Mount Maquiling, *Reinking 1080,* on dead bark.

*Pterospermum obliquum* Blanco, Mount Maquiling, *Reinking 3128,* on dead branches.

**AURICULARIA VELUTINA** (Lév.) Pat.

*Ficus benjamina* Linn., Mount Maquiling, *Pañganiban 1010,* on dead branches.

## TREMELLACEAE

### HETEROCHAETE Patouillard

**HETEROCHAETE GELATINOSA** (Berk.) Pat.

*Koordersiodendron pinnatum* (Blanco) Merr., Mount Maquiling, Laguna, *Reinking 6469,* on dead branches.

### DUPORTELLA Patouillard

**DUPORTELLA TRISTIUSCULA** (Berk.) Pat. (*D. velutina* Pat. = *Corticium tristiusculum* Berk. = *Hymenochaete tristiusculum* Massee.)

*Acacia farnesiana* (Linn.) Willd., Mount Maquiling, *Reinking 3985,* on dead branches.

*Albizzia procera* (Roxb.) Benth., Mount Maquiling, *Reinking 4420,* on dead twigs.

*Barringtonia racemosa* (Linn.) Blume, Mount Maquiling, *Reinking 4288,* on dead branches.

*Bauhinia,* Mount Maquiling, *Reinking 4051,* on dead branches.

*Caesalpinia sappan* Linn., Mount Maquiling, *Reinking 4227,* on dead twigs.

*Celtis philippensis* Blanco, Mount Maquiling, *Reinking 4228,* on dead twigs.

*Citrus maxima* (Burm.) Merr. (*Citrus decumana* Linn.), College Ground, Los Baños, *Reinking 4020,* on dead twigs.

*Clerodendron minahassae* Teysm. & Binn., Mount Maquiling, *Reinking 2687,* on dead wood.

*Eriobotrya japonica* Lindl., Mount Maquiling, *Reinking 4081,* on dead wood.

*Eugenia jambolana* Lam., Mount Maquiling, Reinking *4449*, on dead branches.

*Evodia*, Mount Maquiling, *Reinking 4439*, on dead twigs.

*Ficus nota* (Blanco) Merr., Mount Maquiling, *Reinking 3970*, on dead branches.

*Grevillea robusta* A. Cunn., Mount Maquiling, *Reinking 3927*, on dead branches.

*Lagerstroemia speciosa* (Linn.) Pers., Mount Maquiling, *Reinking 4255*, on dead branches.

*Macaranga tanarius* (Linn.) Muell.-Arg., Mount Maquiling, *Reinking 3999*, on dead branches.

*Mangifera indica* Linn., College Ground, Los Baños, *Reinking 3996*, on dead branches.

*Parashorea plicata* Brandis, Mount Maquiling, *Reinking 3952*, on dead branches.

*Parinarium griffithianum* Benth., Mount Maquiling, *Reinking 4058*, on dead branches.

*Premna* sp., Mount Maquiling, *Reinking 3917*, on dead branches.

*Pterocarpus indicus* Willd., Mount Maquiling, *Reinking 4418*, on dead twigs.

*Quercus bennettii* Miq., Mount Maquiling, *Reinking 4096*, on dead wood.

*Semecarpus cuneiformis* Blanco, Mount Maquiling, *Reinking 3925*, on dead branches.

*Tamarindus indica* Linn., Mount Maquiling, *Reinking 4060*, on dead branches.

#### TREMELLA Dillenius

**TREMELLA FUCIFORMIS** Berk.

Mount Maquiling, *Marquez 871*, on dead branches.

## DACRYOMYCETACEAE

#### GUEPINIOPSIS Patouillard

**GUEPINIOPSIS SPATHULARIUS** (Schw.) Pat.

*Bambusa vulgaris* Schrad., Mount Maquiling, *Sobrepeña 789*, on living culm.

## THELEPHORACEAE

#### STEREUM Persoon

**STEREUM BORYANUM** Fr.

*Ficus benjamina* Linn., College Ground, Los Baños, *Marquez 971*, on dead branches.

*Ficus religiosa* Linn., Forestry Nursery, Los Baños, *Pañganiban 741*, on dead wood.

**STEREUM LOBATUM** Fr.

Mount Maquiling, *Mendoza 2510*, on dead wood.

**STEREUM MELLISII** Berk.

*Bambusa*, Sulu, Jolo, *Reinking 2432*, on dead culms.

**STEREUM PERLATUM** Berk.

*Mangifera indica* Linn., College Ground, Los Baños, *Collado 1800*, on dead branches.

**STEREUM SPECTABILE** Mont.

Mount Maquiling, *Reyes 1203*, on decaying wood.

**STEREUM SURINAMENSE** Lév.

Mount Maquiling, *Cazeñas 3418*, on dead wood.

### CLADODERRIS Persoon

**CLADODERRIS CAPERATA** Mont. var. **SPONGIGES** (Berk.) Cooke.

*Psidium guajava* Linn., College Ground, Los Baños, *Lontok 998*, on dead leaves.

**CLADODERRIS DENDRITICA** Pers.

*Calamus*, Mount Maquiling, *Collado 1849*, on dead stem.

### PHAEOCYPHELLA Patouillard

**PHAEOCYPHELLA HIBISCI** Pat.

*Morinda bracteata* Roxb., Mount Maquiling, *Reinking 3091*, on dead branches.

## CLAVARIACEAE

### PTERULA Fries

**PTERULA CAPILLARIS** Lév.

*Schizostachyum*, Mount Maquiling, *Reinking 2633*, on dead culms.

**PTERULA FASCICULARIS** Bres. et Pat.

*Annona reticulata* Linn., College Ground, Los Baños, *Reinking 3689*, on dead branches.

**PTERULA SIMPLEX** Sacc. et Paol.

*Bambusa*, College Ground, *Limbo 5585*, on dead culms.

*Bambusa spinosa* Roxb. (*B. blumeana* Schultes), College Ground, Los Baños, *Reyes 383*, on dead culms.

### LACHNOCLADIUM Léveillé

**LACHNOCLADIUM BRASILIENSE** Berk. (*L. samoense* P. Henn.)

Mount Maquiling, *Reyes 230*, on soil.

**LACHNOCLADIUM PUNGENS** Lév. (sub *Merisina*).[1]

Mount Maquiling, *Collado 1349*, on dead wood.

## POLYPORACEAE

### PORIA Persoon

**PORIA (POROGRAMME) FULIGO** Berk.

*Bambusa spinosa* Roxb. (*B. blumeana* Schultes), Mount Maquiling, Laguna, *Zschokke 5967*, on dead culms.

**PORIA (POROGRAMME) RAVENALAE** Berk.

*Livistona rotundifolia* Mart., Los Baños, Laguna, *Serrano 6571*, on dead leaf petioles.

### GANODERMA Karstner

**GANODERMA LEUCOPHAEUM** (Mont.) Pat.

Mount Maquiling, *Baybay 3376*, on dead branches.

**GANODERMA RUGOSUM** Nees.

Mount Maquiling, *Santos 413*, on soil.

### POLYPORUS Micheli

**POLYPORUS AFFINIS** Nees.

Mount Maquiling, *Cazeñas 3432*, on dead branches.

**POLYPORUS ARCULARIUS** Fr.

Mount Maquiling, *Marquez 1086*, on dead wood.

**POLYPORUS BICOLOR** Jungh.

*Ficus benjamina* Linn., Mount Maquiling, *Pañganiban 966*, on dead wood.

**POLYPORUS CARYOPHYLLI** Racib.

*Citrus*, Los Baños, *Pañganiban 211*, on dead wood.

**POLYPORUS COHERENS** Lév.

Mount Maquiling, *Nantes 2517*, on dead wood.

**POLYPORUS CONTRACTUS** Berk.

Mount Maquiling, *Pañganiban 3334*, on dead branches.

**POLYPORUS GRAMMOCEPHALUS** Berk.

Mount Maquiling, *Marquez 978*, on dead branches.

[1] Patouillard notes that this is a species which does not seem to have been refound since its collection at Java by Zollruger. It has nothing in common with the one which Hennings named *Pterula pungens*.

POLYPORUS HIRSUTUS Fr.

*Citrus nobilis* Lour., Los Baños, *Lindayag 1257*, on dead wood.

POLYPORUS INAMCENUS Mont.

Mount Maquiling, *Nantes 660*, on dead wood.

POLYPORUS LICNOIDES Mont.

*Lansium domesticum* Correa, Los Baños, *Hernandez 1211*, on dead wood.

POLYPORUS MELAENUS Lév.

Mount Maquiling, *Nantes 2485*, on dead wood.

POLYPORUS PACHYPHLOEUS Pat.

*Parashorea plicata* Brandis, Mount Maquiling, *Collado 1397*, on dead wood.

POLYPORUS PINSITUS Fr.

*Leucaena glauca* Benth., Mount Maquiling, *Jimenez 3190*, on dead wood.

POLYPORUS RIGIDUS Lév.

Mount Maquiling, *Nantes 679*, on dead wood.

POLYPORUS RUGULOSUS Lév.

*Bambusa*, Sulu, Jolo, *Reinking 2433*, on dead culms.

*Bambusa vulgaris* Schrad., Mount Maquiling, *Reyes 320*, on dead culms.

*Strychnos nux-vomica* Linn., Mount Maquiling, Laguna, *Reinking 6448*, on dead branches.

POLYPORUS VELLEREUS Berk.

*Gliricidia sepium* (Jacq.) Steud., Mount Maquiling, *Reyes 269*, on dead wood.

POLYPORUS XANTHOPUS Fr.

Mount Maquiling, *Reinking 3449*, on dead branches.

## TRAMETES Fries

TRAMETES DERMATODES Lév.

*Clerodendron minahassae* Teysm. & Binn., Mount Maquiling, *Reinking 4275*, on dead branches.

TRAMETES MEYENII Kl.

*Pithecolobium dulce* (Roxb.) Benth., Mount Maquiling, *Divinagracia 1054*, on decaying wood.

**TRAMETES OCCIDENTALIS** Fr.

Mount Maquiling, *Reinking 3171,* on dead wood.

**TRAMETES PERSOONII** Mont.

*Manihot utilissima* Pohl, Los Baños, *Morada 3204,* on dead stem.

**TRAMETES TEGULARIS** Lév.

Mount Maquiling, *Nantes 912,* on dead wood.

### LENZITES Fries

**LENZITES PALISOTI** Fr.

*Bambusa spinosa* Roxb. (*Bambusa blumeana* Schultes), Mount Maquiling, *Villanueva 972,* on dead culms.

*Clerodendron minahassae* Teysm. & Binn., Mount Maquiling, *Reinking 2697,* on dead wood.

*Macaranga tanarius* (Linn.) Muell.-Arg., Mount Maquiling, *Marajas 913,* on dead bark.

### HEXAGONA Fries

**HEXAGONA THWAITESII** Berk. var. **RETROPICTA** Bres.

*Cordia myxa* Linn., Mount Maquiling, *Pañganiban 1013,* on dead wood.

*Gliricidia sepium* (Jacq.) Steud., Mount Maquiling, *Villanueva 220,* on dead branches.

### LASCHIA Montagne

**LASCHIA CUTICULARIS** Lév.

*Bambusa,* College farm, Los Baños, *Collado 58,* on dead culms.

### POROLASCHIA Patouillard

**POROLASCHIA TONQUINENSIS** Pat.

*Bambusa vulgaris* Schrad., var. *striata* (Lodd.) Gamble, College farm, Los Baños, *Reyes 309,* on dead culms.

### FAVOLUS Fries

**FAVOLUS MULTIPLEX** Lév. (*Favolus spathulatus* Jungh.)

*Ficus,* Mount Maquiling, *Collado 1461,* on dead wood.

**FAVOLUS PHILIPPINENSIS** Berk. var. **OBSCURATA** Bres.

Mount Maquiling, *Reyes 3318,* on dead wood.

### LEUCOPORUS Patouillard

**LEUCOPORUS ARCULARIUS** (Fr.) Pat.

Mount Maquiling, Laguna, *Collado 1369,* on dead branches.

**LEUCOPORUS GALLOPAVONIS** (Berk.) Pat.

*Cocos nucifera* Linn., Los Baños, *Alas 3178*, on dead trunk.

## AGARICACEAE

### TROGIA Fries

**TROGIA PARTITA** (Berk.) Pat.

Mount Maquiling, *Cazeñas 3399*, on dead wood.

### SCHIZOPHYLLUM Fries

**SCHIZOPHYLLUM COMMUNE** Fr.

*Blumea balsamifera* (Linn.) DC., Mount Maquiling, *Reinking 2831*, on dead wood.

*Hevea brasiliensis* (HBK.) Muell.-Arg., Mindanao, *Reinking 2782*, on dead roots.

*Kigelia pinnata* DC., Mount Maquiling, *Reinking 3320*, on dead branches.

*Mallotus ricinoides* (Pers.) Muell.-Arg., Mount Maquiling, *Reinking 3106*, on dead branches.

*Manihot utilissima* Pohl, Los Baños, *Morada 3196*, on dead stem.

*Persea gratissima* Gaertn., Mount Maquiling, *Reinking 2811*, on dead wood.

*Tamarindus indica* Linn., College Ground, Los Baños, *Reinking 2855*, on dead wood.

### XEROTUS Fries

**XEROTUS NIGRITA** Lév.

Los Baños, *Divinagracia 3439*, on dead branches.

### LENTINUS Fries

**LENTINUS BRACCATUS** Lév.

*Oryza sativa* Linn., Los Baños, *Ocfemia 3898*, on dead sterile panicles.

**LENTINUS VILLOSUS** Kl.

Mount Maquiling, *Reinking 3169*, on dead wood.

### CRINIPELLIS Patouillard

**CRINIPELLIS GALEATUS** (B. et C.) Pat.

*Prosopis vidaliana* Naves, Mount Maquiling, *Reinking 3122*, on dead branches.

**CRINIPELLIS STIPITARIA** Pers.

*Litsea perrottetii* F.-Vill., Mount Maquiling, *Catalan 4464*, on dead twigs.

## CLATHRACEAE

### SIMBLUM Klotzsch

**SIMBLUM GRACILE** Berk. (*S. periphragmoides* Kl. = *S. flavescens* Berk.)

*Bambusa*, Los Baños, *Ocfemia 4149*, on post.

## LYCOPERDACEAE

### CALVATIA

**CALVATIA LILACINA** (Mont.) Pat.

Mount Maquiling, *Reinking 3275*, on dead branches.

### FUNGI LISTED ACCORDING TO HOSTS

ACACIA FARNESIANA (Linn.) Willd.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

ALBIZZIA PROCERA (Roxb.) Benth.
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

ANNONACEAE.
*Auricularia mesenterica* (Dicks.) Fr., dead branches.

ANNONA MURICATA Linn.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

ANNONA RETICULATA Linn.
*Pterula fascicularis* Bres. et Pat., dead branches.

BAMBUSA.
*Laschia cuticularis* Lév., dead culms.
*Polyporus rugulosus* Lév., dead culms.
*Pterula simplex* Sacc. et Paol., dead culms.
*Simblum gracile* Berk., on post.
*Stereum mellisii* Berk., dead culms.

BAMBUSA SPINOSA Roxb. (*Bambusa blumeana* Schultes.)
*Lenzites palisoti* Fr., dead culms.
*Poria* (*Porogramme*) *fuligo* Berk., dead culms.
*Pterula simplex* Sacc. et Paol., dead culms.

BAMBUSA VULGARIS Schrad.
*Guepiniopsis spathularius* (Schw.) Pat., living culm.
*Polyporus rugulosus* Lév., dead culms.

BAMBUSA VULGARIS Schrad. var. STRIATA (Lodd.) Gamble.
*Porolaschia tonquinensis* Pat., dead culms.

BARRINGTONIA RACEMOSA (Linn.) Blume.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

BASSIA BETIS (Blanco) Merr.
*Auricularia mesenterica* (Dicks.) Fr., dead branches.

BAUHINIA.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

BIXA ORELLANA Linn.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

BLUMEA BALSAMIFERA (Linn.) DC.
*Schizophyllum commune* Fr., dead wood.

CAESALPINIA SAPPAN Linn.
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

CALAMUS.
*Cladoderris dendritica* Pers., dead stem.

CANARIUM VILLOSUM (Miq.) F.-Vill.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

CELTIS PHILIPPENSIS Blanco.
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

CITRUS.
*Polyporus caryophylli* Racib., dead wood.

CITRUS MAXIMA (Burm.) Merr. (*Citrus decumana* Linn.)
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

CITRUS NOBILIS Lour.
*Polyporus hirsutus* Fr., dead wood.

CLEIDION JAVANICUM Blume.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

CLERODENDRON MINAHASSAE Teysm. & Binn.
*Duportella tristiuscula* (Berk.) Pat., dead wood.
*Lenzites palisoti* Fr., dead wood.
*Trametes dermatodes* Lév., dead branches.

COCOS NUCIFERA Linn.
*Leucoporus gallopavonis* (Berk.) Pat., dead trunk.

CORDIA MYXA Linn.
*Hexagona thwaitesii* Berk. var. *retropicta* Bres., dead wood.

ERIOBOTRYA JAPONICA Lindl.
*Duportella tristiuscula* (Berk.) Pat., dead wood.

EUGENIA JAMBOLANA Lam.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

EUPHORBIA HYPERICIFOLIA Linn.
*Auricularia tenuis* Lév., dead bark.

EVODIA.
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

FICUS.
*Favolus multiplex* Lév., dead wood.

FICUS ANGUSTISSIMA Merr.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

FICUS BENJAMINA Linn.
*Auricularia velutina* (Lév.) Pat., dead branches.
*Polyporus bicolor* Jungh., dead wood.
*Stereum boryanum* Fr., dead branches.

FICUS NOTA (Blanco) Merr.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

FICUS RELIGIOSA Linn.
*Stereum boryanum* Fr., dead wood.

GLIRICIDIA SEPIUM (Jacq.) Steud.
*Hexagona thwaitesii* Berk. var. *retropicta* Bres., dead branches.
*Polyporus vellereus* Berk., dead wood.

GREVILLEA ROBUSTA A. Cunn.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

HEVEA BRASILIENSIS (HBK.) Muell.-Arg.
*Schizophyllum commune* Fr., dead roots.

KIGELIA PINNATA DC.
*Schizophyllum commune* Fr., dead branches.

KOORDERSIODENDRON PINNATUM (Blanco) Merr.
*Auricularia polytricha* (Mont.) Sacc., dead branches.
*Heterochaete gelatinosa* (Berk.) Pat., dead branches.

LAGERSTROEMIA SPECIOSA (Linn.) Pers.
*Auricularia polytricha* (Mont.) Sacc., dead branches.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

LANSIUM DOMESTICUM Correa.
*Polyporus licnoides* Mont., dead wood.

LEUCAENA GLAUCA Benth.
*Polyporus pinsitus* Fr., dead wood.

LITSEA PERROTTETII F.-Vill.
*Crinipellis stipitaria* Pers., dead twigs.

LIVISTONA ROTUNDIFOLIA Mart.
*Poria* (*Porogramme*) *ravenalae* Berk., dead leaf petioles.

MACARANGA TANARIUS (Linn.) Muell.-Arg.
*Duportella tristiuscula* (Berk.) Pat., dead branches.
*Lenzites palisoti* Fr., dead bark.

MALLOTUS RICINOIDES (Pers.) Muell-Arg.
*Schizophyllum commune* Fr., dead branches.

MANGIFERA INDICA Linn.
*Duportella tristiuscula* (Berk.) Pat., dead branches.
*Stereum perlatum* Berk., dead branches.

MANIHOT UTILISSIMA Pohl.
*Auricularia polytricha* (Mont.) Sacc., dead stem.
*Schizophyllum commune* Fr., dead stems.
*Trametes persoonii* Mont., dead stems.

MORINDA BRACTEATA Roxb.
*Phaeocyphella hibisci* Pat., dead branches.

ORYZA SATIVA Linn.
*Lentinus braccatus* Lév., dead sterile panicles.

178259——4

PARASHOREA PLICATA Brandis.
*Duportella tristiuscula* (Berk.) Pat., dead branches.
*Polyporus pachyphloeus* Pat., dead wood.

PARINARIUM GRIFFITHIANUM Benth.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

PERSEA GRATISSIMA Gaertn.
*Schizophyllum commune* Fr., dead wood.

PITHECOLOBIUM DULCE (Roxb.) Benth.
*Trametes meyenii* Kl., decaying wood.

PREMNA sp.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

PROSOPIS VIDALIANA Naves.
*Crinipellis galeatus* (B. et C.) Pat., dead branches.

PSIDIUM GUAJAVA Linn.
*Cladoderris caperata* Mont. var. *spongiges* (Berk.) Cooke, dead leaves.

PTEROCARPUS INDICUS Willd.
*Duportella tristiuscula* (Berk.) Pat., dead twigs.

PTEROSPERMUM OBLIQUUM Blanco.
*Auricularia tenuis* Lév., dead branches.

QUERCUS BENNETTII Miq.
*Duportella tristiuscula* (Berk.) Pat., dead wood.

SCHIZOSTACHYUM.
*Pterula capillaris* Lév., dead culms.

SEMECARPUS CUNEIFORMIS Blanco.
*Duportella tristiuscula* (Berk.) Pat., dead branches.

SOLANUM GRANDIFLORUM Ruiz et Pav.
*Auricularia polytricha* (Mont.) Sacc., dead stems.

STREBLUS ASPER Lour.
*Auricularia polytricha* (Mont.) Sacc., dead branches.

STRYCHNOS NUX-VOMICA Linn.
*Polyporus rugulosus* Lév., dead branches.

TAMARINDUS INDICA Linn.
*Duportella tristiuscula* (Berk.) Pat., dead branches.
*Schizophyllum commune* Fr., dead wood.

# MYRMECONAUCLEA, A NEW GENUS OF RUBIACEOUS PLANTS FROM PALAWAN AND BORNEO

By Elmer D. Merrill

*Director and Botanist, Bureau of Science, Manila*

**MYRMECONAUCLEA** genus novum

Flores in capitulum globosum compacti, ebracteolati, calycibus arcte concretis, lobis 5, partes deciduae spathulatae, partes persistentes lanceolatae. Corollae tubus anguste infundibularibus. Stamina in tubo corollae inclusa. Stylus elongatus, stigma subglobosum. Fructus in syncarpium globosum vel depresso-globosum connati, endocarpium superne incrassatum. Semina longe alata. Arbuscula, foliis oppositis, stipulatis; capitulis solitariis, terminalibus bracteatis.

**MYRMECONAUCLEA STRIGOSA** (Korth.) comb. nov.

*Nauclea strigosa* Korth. Verh. Nat. Gesch. (1839–42) 157; Miq. Fl. Ind. Bat. 2 (1857) 138; Havil. in Journ. Linn. Soc. Bot. **33** (1897) 52, *t. 2.*

*Sarcocephalus fluviatilis* Elm. Leafl. Philip. Bot. 4 (1912) 1357.

*Neonauclea strigosa* Merr. in Journ. Wash. Acad. Sci. **5** (1915) 542.

This characteristic species was originally described from Bornean material, and is at present known only from Borneo and Palawan. Haviland has given an excellent detailed figure of it, and also gives a rather lengthy discussion of it. Korthals had no fruiting specimen, and hence placed it in the genus *Nauclea* (= *Neonauclea*). Haviland followed him in this disposition of it although he indicated that it was anomalous in this genus in that its fruit is concrete and forms a syncarp. I consider that it is as anomalous in *Sarcocephalus,* where it was placed by Elmer, as it is in *Nauclea* and accordingly have proposed a new generic name for it. It differs radically from *Nauclea* auct. (= *Neonauclea*) in its concrete fruits forming a syncarp and as radically from *Sarcocephalus* (= *Nauclea* Linn.) in its winged seeds.

Haviland has discussed somewhat at length the peculiar fruit characters of this species, but he apparently did not have fully mature fruits. In age the persistent tips of the calyx segments fall, leaving a small perforation at the apex of each individual fruit through which it is apparent that the small, slender, winged seeds escape, dissemination of seeds apparently covering a considerable period of time.

The generic name is derived from the Greek μύρμηκος, ant, and *Nauclea,* a genus to which the present one is closely allied, as a certain percentage of the branchlets always present hollow swellings, perforated on one side, which are inhabited by colonies of small ants.

In habitat the species is exceedingly characteristic, as it always grows on the banks, and on gravel bars in the beds, of small shaded mountain streams, always in places subject to overflow in times of heavy rain; frequently the shrubs stand in constantly running water as does the euphorbiaceous *Homonoia riparia* Lour. It occurs in Palawan at altitudes from sea level to about 300 meters.

I have examined the following material representing the species: BORNEO, Sarawak, Mount Merinjak, *Native collector 2588, 2620* (*Bur. Sci.*). PALAWAN, Alfonso XIII, *For. Bur. 21587 Danao,* April 9, 1914; Caruray, *For. Bur. 27289 Flores;* Taytay, *Merrill Phil. Pl. 1201;* Napsahan, *Merrill 7234;* region of Puerto Princesa, *Merrill 724, Elmer 12848.* The Philippine specimen cited by Haviland as *Vidal 1445* is *Vidal 1448.* It is labeled as from Luzon but in all probability came from Palawan.

# COMMENTS ON COOK'S THEORY AS TO THE AMERICAN ORIGIN AND PREHISTORIC POLYNESIAN DISTRIBUTION OF CERTAIN ECONOMIC PLANTS, ESPECIALLY HIBISCUS TILIACEUS LINNAEUS

By Elmer D. Merrill

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Mr. O. F. Cook, of the United States Department of Agriculture, has given considerable attention to the theory of the American origin and the prehistoric distribution across Polynesia of various economic plant species, and has published several papers on the subject. In this series of papers there is considerable evidence that their author is inclined to draw conclusions from insufficient data, involving a lack of personal knowledge of the several species as they occur in nature in various parts of the world, especially in the Old World. It would seem also that, accepting the theory of American origin for a particular species, he is prone to discuss the data in support of that theory, subordinating or overlooking facts that are contrary to the general thesis. The result is that the arguments as presented and the conclusions derived therefrom are not always conclusive, and are certainly not always convincing from either a botanical or a philological standpoint.

He has attempted to prove the American origin of the coconut (*Cocos nucifera* Linn.), and its transmission by the Polynesians across Polynesia to Malaya and tropical Asia in prehistoric times,[1] but more convincing to me are the arguments of Dr. O. Beccari[2] that it is a native of Polynesia or tropical Asia, and that it is a halophilous plant, which may have been disseminated in part by ocean currents.

Beccari, among other criticisms of Cook's arguments, has shown that the palm does occur wild in nature, as witnessed by its unaided development on the isolated and uninhabited Palmyra

[1] The origin and distribution of the cocoa palm, Contr. U. S. Nat. Herb. 7 (1901) 257–293; History of the coconut palm in America, Contr. U. S. Nat. Herb. 14 (1910) 271–342.

[2] Beccari, O., The origin and dispersal of Cocos nucifera, Philip. Journ. Sci. 12 (1917) Bot. 27–43.

Islands, and that it can compete successfully with the arborescent vegetation of tropical strand floras. He has called attention to the fallacy of the statement that Cook makes regarding the plant as seldom growing on the immediate strand, a statement certainly made without sufficient knowledge of the species as it grows in nature; for, as Beccari indicates, the immediate strand is the habitat par excellence for this palm in the vast Indo-Malayan-Polynesian region, as is witnessed by tens of thousands of miles of palm-lined shores in the Philippines and in the Tropics of the Old World as a whole. Again in support of his general thesis that the coconut was not disseminated by ocean currents, Cook illogically argues that the chances are hundreds to one that coconuts falling into the water will be thrown back immediately upon their own coast like other objects floating in the surf, and further that: "High waves or tides, instead of floating shore débris away, merely carry it farther inland, as everybody familar with seacoasts knows." If this be always true, as Beccari notes, we should have to evolve some other theory to explain the geographic distribution of the characteristic elements of the strand floras of the world. The revegetation of Krakatao, so far as its present strand flora is concerned, is in direct opposition to the idea that shore débris is *always* carried farther inland by the waves as Cook infers.

Messrs. O. F. and R. C. Cook[3] have recently made the claim that *Hibiscus tiliaceus* Linn. appears to have been distributed over the islands and shores of the Pacific and Indian Oceans before the arrival of Europeans—a claim that no botanist familiar with the geographic distribution of this characteristic species will dispute. When, however, they infer that the primitive Polynesians were in possession of this species before they became acquainted with similar Asiatic plants; that it may have been carried by them from America across the tropical regions of the Old World; and that, therefore, it is one of the economic plants to be taken into consideration in studying the problem of contacts between the inhabitants of tropical America and Polynesia in prehistoric times, it would seem advisable to present the data in opposition to this argument.

With their first contention, "The maho [*Hibiscus tiliaceus* Linn.] * * * appears to have attained a trans-Pacific distribution in prehistoric times," no fault can be found, as the species is one having a true, and certainly natural, pantropic

[3] Cook, O. F., and Cook, R. C., The maho, or mahagua, as a trans-Pacific plant, Journ. Wash. Acad. Sci. **8** (1918) 153–170.

distribution. We later read: "As with the coconut palm and the sweet potato, the *maho* figures more prominently among the Polynesians than among the natives of tropical America, although the American origin of the plant is *even more clearly indicated*" [italics mine]. The paragraph headings "A wild plant in America" and "A cultivated plant in the Old World" emphasize the fact that the authors are unacquainted with the plant as it occurs in the Old World. All botanists familiar with this common species as it occurs in the vast Indo-Malayan region will at once realize that the last paragraph heading is exceedingly misleading.

They concede that the plant is wild and of wide distribution in tropical America, a region with which they are familiar, where it grows naturally along the seashore; but they make the most curious general claim that it is a cultivated plant in the Tropics of the Old World, a region they have apparently never visited. They admit that in some Polynesian islands it grows spontaneously and covers large areas that have been abandoned after previous cultivation, and that low banks of tidal rivers are its favorite habitat. They do not, however, accept the statements made by numerous botanists, many of whom were familiar with the plant in its native habitat in the Old World, that it is a pantropic strand plant. Their theory regarding *Hibiscus tiliaceus* is apparently based largely on the fact that they know the species from personal observation to be a native strand plant in tropical America, plus the statement in various published works that it is cultivated in Polynesia, and the assumption that it is also cultivated in other parts of the Old World Tropics. This being so, they could then reason its transmission by man from the New to the Old World, and interpret various data in support of that hypothesis.

As a matter of fact, outside of Polynesia the species is never cultivated in the Tropics of the Old World, although one occasionally finds individual trees planted inland for ornamental purposes, while on the islands of the Pacific its cultivation is by no means universal; for here, as elsewhere, it is of wide natural distribution along the seashore, and on many islands (Guam for example) it occurs in enormous quantities forming gregarious thickets near the sea. In tropical Asia and Malaya the plant is not of sufficiently great economic importance to warrant its cultivation, and in these vast regions it is certainly not a species that has purposely been disseminated by man, in either prehistoric or historic times. On some Pacific islands it occurs gregariously inland, where it sometimes almost exclusively occupies considerable areas, as I have personally observed in Hawaii. The reasons for its cultivation on some Polynesian islands were undoubtedly that it was the best, or one of the best, of the few fiber plants available to the primitive Polynesians, and that the number of plants growing naturally along the strand was not sufficient to supply the demands for fibers for all purposes. *Hibiscus tiliaceus* was never domesticated or even semidomesticated in tropical America and in the Indo-Malayan region, for the reason that plants producing better fibers were available in both regions.

I maintain on purely botanical evidence that *Hibiscus tiliaceus* is a species of natural pantropic distribution; that it grows in practically all tropical countries along the seashore, its natural habitat; and that it has been disseminated in ages past by ocean currents. Its seeds are beautifully adapted to dissemination by floating for, although small, they are provided with a smooth impervious testa, and float for many months without sinking. In fact, no one has as yet recorded his ability to cause them to sink naturally, investigators being satisfied from experimentation with the statement that they "float for months."

Even in Polynesia it is exceedingly doubtful if the Polynesians transmitted this species from island to island, it being far more probable that they purposely propagated it inland from the native seacoast stock on the various islands. From personal experience over a period of more than eighteen years I am familiar with the entire Philippine group from northern Luzon to southern Mindanao, and have observed that throughout these islands *Hibiscus tiliaceus* is a characteristic species of the seashore, often being the dominant, or one of the dominant, species on the strand; it occurs not only on beaches contiguous to thickly settled areas but also on isolated and sparsely populated coasts, and on uninhabited islands and islets. From what I know of the Indo-Malayan region generally I am confident that the species occurs similarly on the tens of thousands of miles of coast line throughout tropical Asia, Africa, Malaya, tropical Australia, and many islands of the Pacific, as I have personally observed it in the Philippines and in the Marianne Islands. There can scarcely be any arguments as to other than its natural pantropic distribution, and claims to the contrary would appear to be not in conformity with the known facts regarding its occurrence and distribution in nature.

Being thoroughly familiar with *Hibiscus tiliaceus* as it occurs in nature in the Old World, it is difficult for me to conceive how any botanist could seriously advance the argument that it is a native of tropical America transmitted to the Old World by the primitive Polynesians and, as a corollary, attempt to prove intercommunication between Polynesia and tropical America in prehistoric times on the basis of the present pantropic distribution of this species. That a limited intercommunication between Polynesia and tropical America did exist in prehistoric times is entirely probable, but to argue that the present distribution of *Hibiscus tiliaceus* supports this theory certainly does not strengthen the probability.

The generally accepted theory among ethnologists supports an *eastward* culture movement across the Pacific rather than a *westward* one. If the Cook *maho* series is related to the Polynesian *mao* series it would be much more reasonable to view it as coming from the Pacific to America rather than as evidencing a migration from America into the Pacific. If, as they claim, the American origin of *Hibiscus tiliaceus* is *even more clearly indicated* than is the similar origin of the coconut and the sweet potato, the claims to the American origin of the last two must be very weak indeed.

Their argument regarding the origin and distribution of *Hibiscus tiliaceus* is largely based on the similarity between its local names in tropical America and in Polynesia; namely, *maho, mahagua,* etc., in tropical America, and *mao, mau, vau,* etc., in Polynesia. About thirteen pages are devoted to a discussion of the philological questions involved. While many data are given to show the similarity of names in tropical America and Polynesia, it is stated that the names used in Fiji, Guam, and the Philippines may not belong to the *maho* series. The large number of Malay Archipelago names is ignored, but the statement is made that local names used in Madagascar and the neighboring islands appear to connect with the Malay and Polynesian series.

The recorded names for the species in the Philipipnes are *bago, bauan, balobago, balibago, malabago, malabagu, malambago, mayambago, mulabago, danglog, loago, hanot,* and *hanut;* of these *balibago* and *malabago* are the ones most commonly and widely used. The recorded names for the Malay Archipelago, not mentioned by Cook, are *balebirang, baoe, baoek, baroe, baroe bhender, haoe ai, haroe, kabaroe, kalimbaoean, kasjanaf, kawaoean, kelambaoean, kioko, lago, molombagoe, molowahoe, papatpat, pohon baoek, siroen, wahoe, wande, waoe, waroe, waroe* *laoet* (*laoet*=ocean), *waroe lenga*, and *waroe lengis*. These names are from Dutch sources, and it should be borne in mind that in Dutch orthography *oe* represents the sound *u*.

As noted above, the authors state that it may be doubted whether names like *vahu, balibago*, and *pago*, used in Fiji, the Philippine Islands, and Guam, belong in the *maho* series, but consider that the relation seems possible in view of the intermediate Polynesian forms like *bago, faga*, and *haga*. They do not discuss the Malayan names enumerated above, but with the statement that they appear to connect with the Malayan and Polynesian series they list the following names from Madagascar and neighboring islands: *baro, var, varo, vau*, and *vaur*. Among the names in use in India, *bariá* and *baru* are suggestively like many of the Malayan, Mascarene, and Polynesian names.

Not being qualified personally to discuss the philological questions involved, and yet confident on purely botanical grounds that *Hibiscus tiliaceus* is a strand plant of natural pantropic distribution, at my request Prof. H. Otley Beyer, of the department of anthropology, University of the Philippines, and Mr. E. E. Schneider, of the Philippine Bureau of Forestry, have examined Cook's paper and my notes on which this article is based. Both of these men are authorities on Philippine languages and both are deeply interested in the comparative philology of Indo-Malayan, Philippine, and Polynesian languages. Professor Beyer, whom I first consulted, has called my attention to the fact that the Polynesian *mao* series may well have been derived from some of the Malayan forms by the suppression of consonants, which is a fundamental characteristic of the Polynesian group of languages as contrasted with the Malayan languages. It seems to me to be entirely probable that the original form or root in the Indo-Malayan region was some word like *bago* or *baru*. It is to be noted that with the substitution of *m, f*, and *v* for the initial *b*, and *h* for *g* or *r*, or the suppression of the latter two letters, we have a series of names that approximate the Polynesian *mao* series given by Cook as *mao, mau, au, hau, fau*, and *vau*. The probabilities are very great that all of the Polynesian *mao* series are merely modifications of the Indo-Malayan *bago* series; and that the Polynesians in their migration, having adopted the name while in the Indo-Malayan region, merely applied it to the wild plant which they found all over Polynesia. It would seem, therefore, that this root has nothing to do with the tropical American *maho* series, the resemblances being merely accidental. The *bago* origin of the *mao* series is a great deal more likely than the *maho* origin, and infinitely more probable in view of the generally accepted theories as to the origin and migrations of the Polynesians. It is, moreover, not, as these authors contend, in violent opposition to the known distribution and occurrence in nature of the species under discussion.

Mr. Schneider is in full agreement with the *bago* or *baru* origin of the Polynesian *mao* series. He considers that one of the weakest spots in Cook's argument is the expressed doubt that the Fijian *vahu,* the Philippine *balibago,* and the Guam *pago* belong to the *mao* series. He states that the very wide distribution of the *bago* form in the Indo-Malayan region indicates that it is as near as we can get to the original root, whatever that may be. The fact that *r, g,* and *h* are interchangeable in certain series of words in most of the Indo-Malayan languages is as well established as is any of Grimm's laws in the European languages. He considers that there can be hardly any doubt that the Indian *baru* is identical with the Philippine *bago.* The final disappearance of the *h* when intervocalic is not uncommon in Tagalog and in other Philippine languages. Guam *p* for Philippine *b* is perfectly regular, as is *v.* Finally, the weakening of initial *b* to *m* is very common—for example, the plant names *banaba, manaba; binunga, minunga; batavia, matavia;* and, as to *malabago* itself, this is apparently nothing but a reduplicated form with weakened initial *b,* of which other examples are to be found, such as *matobato.*

As to the meaning and application of the name *maho* Mr. Schneider further points out that, whether it was originally the name of some bast-producing plant that was also applied to others that either produced bast or resembled them in external appearance, or a word primarily meaning "bast" and "to tie," is perhaps a question which cannot be decided and, moreover, is of no great importance. The wide distribution of the word has nothing to do with this, however, the following notes indicating what seems to him to be a more probable alternative, namely, that "bast" is the original meaning of the word *maho. Bago,* to use now a Philippine name, is one of the most commonly used names for *Gnetum gnemon,* the bast of which is probably the strongest found in the Philippines and used wherever very strong cordage is desired. *Salago,* in which the same root occurs, is widely used for species of *Wikstroemia* and *Phaleria,* both producing a very fine and extremely tough bast. A parallel case is that of the other name, *hanot,* cited above for *Hibiscus* *tiliaceus;* this, in very numerous forms, of which *banot, bonot, lanot, lanutan, wanoet* (Dutch spelling), *lapnot,* and *lapnit* are a few, is applied to even more numerous species of plants than is *bago,* but also invariably to plants producing some kind of bast fiber or tying material. Examples from widely different plants to which these names are applied are species of Annonaceae; representatives of Malvaceae; various species of vines, representing diverse families, which may either be used whole or which produce bast (*Bauhinia cumingiana*); palms having a network of fibers about the bast of leaf stalks; coir; the epidermal layers from the leaf sheaths of abacá (*Musa textilis*); and finally rattans. Mr. Schneider considers that these cases seem to indicate the derivation of the plant names from a common property rather than the derivation of names of various plants from a primitive or original name of a single species. Is not the American bass wood (bast-wood!) a perfectly analogous case?

It would seem that the argument of these authors as to the American origin of *Hibiscus tiliaceus* and its prehistoric distribution across Polynesia by the Polynesians to the Tropics of the Old World was based on erroneous assumptions on their part, from both a botanical and a philological standpoint, and that their deductions are not borne out by the facts in the case.

# AN ATYPICAL AMŒBA CAUSING DYSENTERIC LESIONS

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THREE COLORED PLATES

Although many of the findings of Schaudinn(5) on *Entamœba histolytica* and *E. coli* have since been controverted by subsequent observers, that portion of his work on *Entamœba histolytica* in which he has proved that it is the sole pathogenic species in man, all others being nonpathogenic, has received ample confirmation from workers in all parts of the world. In fact, by the term amœbic dysentery we understand dysentery caused by *Entamœba histolytica* Schaudinn. Viereck's *Entamœba tetragena* and Elmassian's *E. minuta* have been proved to be phases of *E. histolytica.* Hartmann's *Entamœba africana* has been proved to be identical with the "tetragena phase" of *E. histolytica.* Accordingly, the importance of finding an amœba causing fatal dysenteric lesions and differing from the classical pathogenic species in its nuclear and other characters can well be appreciated.

The patient, from whom the material forming the subject matter of the present paper was obtained, was admitted to the Medical College Hospital, Calcutta, in a moribund condition. He died a few hours after admission. At the autopsy, which was held three hours after death, the large intestine was found inflamed and ulcerated throughout. A portion near the rectum was in a sloughing condition. In parts not so severely affected were found small, circular, elevated ulcers in the middle of which there was a central slough—an appearance which is well known as pathognomonic of amœbic dysentery. Near the cæcum, some coils of intestine were found matted together. However, no distinct perforation could be made out. A peculiarity not ordinarily found in amœbic dysentery was a large elevated inflammatory patch on the peritoneal surface of the wall of a portion of the intestine that was matted together. A smear was made from this inflamed patch on the peritoneal side, and this was examined microscopically. I was surprised to find numerous actively motile amœbæ. On forcibly opening the adherent coils of the intestine, a large collection of creamy pus was found inside the cavity formed by the adherent coils of the intestine. The pus cavity was found completely surrounded by the coils; no opening joining the cavity with the lumen of the intestine could be discovered. Smears of the pus showed numerous actively motile amœbæ. On staining the smears the pus was found to be free from other microörganisms. Several stained preparations were made from this pus. Another peculiarity found in the case was the presence of dysenteric lesions in the small intestine extending about 3 inches above the ileocœcal valve. Three typical dysenteric ulcers were found in this area. Lastly, an elongated, elevated, inflammatory patch was found on the peritoneal surface of the small intestine opposite the ulcers—the appearance being similar to that found in the large intestine. Smears from this patch showed an abundance of living amœbæ, while smears from the other portions of the peritoneal surface of the intestine showed no amœbæ. A portion of the affected small intestine and large intestine were removed for sectioning.

## CHARACTERS OF THE LIVING AMŒBA

In fresh preparations made with pus taken from the pus cavity, numerous actively motile amœbæ were found. As it was not possible to stain preparations at the time that this examination was made, it was not suspected at the time that the amœba differed altogether from the classical type, and accordingly no special attempt was made to make out any distinctive characters of the living amœbæ. All that I remember was that the amœbæ showed marked size differences. Some of them were vacuolated. The ectoplasmic and endoplasmic differentiation was notably marked.

## STAINED PREPARATIONS

Stained preparations were made by making films, fixing them while still wet in acetic acid-picric acid solution and then staining them by a modification of Dobell's iron-hæmatein method. The slides were stained overnight and then differentiated by ferrous alum solution under microscopic control. On cursory examination of these slides under the oil-immersion objective I noticed that the nucleus of the amœba was not of the karyosomic type. On carefully examining a large number of individuals in the several preparations I made, I found the amœbæ showed the following characters:

There was marked variation in the size of the amœbæ, the predominant range being from 16 μ to 20 μ. Many measured from 30 μ to 40 μ. A few were as small as 8 μ. As remarked before, the nucleus was not at all of the *histolytica* type. In most cases, it was oval and quite unlike the circular ring of the *histolytica* nucleus. Plate 1, figs. 1 and 5, show the type of nucleus I found in most cases. It is sometimes rounded (Plate 1, fig. 7). It is situated eccentrically as in *Entamœba histolytica.* There is no differentiation into central and peripheral chromatin. No karyosome is seen. The nucleus stains uniformly dark, and, in some cases, an elongated, unstained patch is seen near the periphery of the nucleus (Plate 1, fig. 6), but in most of the specimens the chromatin and the plastin form a uniformly stained mass. The nuclear membrane is not easily distinguished. In fact, the nucleus is of the "limax" type. It differs from it in not being so dense. It differs from the nucleus of the trophozoite of *Entamœba nana* as described by Wenyon and O'Connor(7) and by Kofoid, Kornhauser, and Swezy(4) in that the chromatin substance is not clumped together at one point on the nuclear membrane leaving the remainder of the nucleus clear. In some of the larger specimens (those measuring 32 μ to 40 μ) the nucleus showed evidence of division by mitosis. Even in division, no separation between peripheral and central layers of chromatin could be distinguished, the entire nucleus being stained uniformly.

In the structure of the cytoplasm this amœba shows well-marked, distinctive characters apart from that of *Entamœba histolytica.* In the former there is a striking distinction between the ectoplasm and the endoplasm. Now, this very character is one of the points of distinction between *Entamœba histolytica* and *E. coli;* but by comparing *Entamœba histolytica* with the amœba under consideration, it will be found that the differentiation between ectoplasm and endoplasm is much more pronounced in the new amœba than it is in *E. histolytica.* In the resting condition of the latter, no noticeable distinction between endoplasm and ectoplasm can be made out, but this is not the case with this amœba. Even in the resting condition a clear, glistening ectoplasm is seen surrounding the stained endoplasm. In the moving specimen during pseudopodium formation this distinction is much more pronounced (Plate 1, fig. 10). The structure of the endoplasm is alveolar in most cases; in a few vacuolation is found (Plate 1, figs. 6 and 8). In a few individuals red blood corpuscles and, in some instances, bacteria were seen to have been ingested (Plate 1, figs. 4 and 13). In none of the specimens were any chromidia blocks seen—a character commonly found in examining specimens of *Entamœba histolytica.*

In order to exclude any source of error due to faulty technic, I had recourse to the following procedure: I made several preparations from different samples of dysenteric stools and passed them through the same fixing and staining processes as the preparations under consideration. On examining the former I had not the slightest difficulty in recognizing the clear, circular *histolytica* nucleus. Furthermore, in bringing out the distinctive points in the characters of this amœba and those of *Entamœba histolytica* I had, for comparison, some permanently mounted specimens from the pus of a case of liver abscess in which there were abundant amœbæ, each field showing fifteen to twenty individuals. The nuclei in these showed all the possible variations described by various authors as cyclic changes. No extreme variation in the shape of the nucleus of *Entamœba histolytica* is comparable to the nucleus of this amœba.

### STUDY OF SECTIONED MATERIAL

As noted before, I made sections through the affected portions of the small and large intestines. These were hardened in alcohol and then embedded in paraffin. The sections were stained in the same way as the smears. A few were stained by Ehrlich's hæmatoxylin, but as these failed to differentiate the amœbæ, this method was given up.

I sectioned through two portions of the small intestine (Plate 2, fig. 2, and Plate 3), one in which there was an ulcer and another in which there was no discontinuity of the mucous membrane. In both, the peritoneal surface showed the lesion seen in fresh material by the unaided eye. I shall describe the peritoneal lesion first as great interest attaches to it. I am not aware of any inflammation of the peritoneum that can be attributed to amœbæ. Moreover, this amœbic peritonitis, if I may be allowed to coin the term, differs entirely from ordinary peritonitis and is, therefore, a distinct pathological entity. This lesion, which was caused by the amœbæ, showed, when the material was fresh, a distinct red elevated patch, in the scrapings from which I found numerous amœbæ. When a stained section of this portion of the small intestine was studied under a low power this patch was noticed to be stained distinctly less faintly than the rest of the tissue (Plate 3, *a*). The thickness of the patch, as will be seen, nearly equals the combined thickness of the transverse and longitudinal muscular coats of the intestine. On examination under high power, it was found to be composed of a dense collection of cells interposed among a granular débris. Between the small faintly stained cells a few large irregularly shaped cells were found under the oil-immersion lens. These were the amœbæ. No collections of red blood corpuscles, or leucocytes, or fibrin threads—so characteristic of inflammatory lesions caused by microörganisms—were found.

Interposed between this faintly stained cellular layer and the longitudinal muscular coat was found a layer of tissue that was very vascular and which took the stain deeply (Plate 3, *b*). This was evidently the subperitoneal tissue. On its outer boundary was seen a layer of cells, evidently the endothelial lining of the peritoneum. Careful study of this vascular subperitoneal layer under the oil-immersion lens showed it to be composed of numerous engorged vessels. The intervening tissue outside the vessels was full of a granular débris, among which were found several large cells. The outlines of these could only be clearly distinguished by constantly changing the focus. These cells showed a single eccentrically placed nucleus. In some, the nucleus could not be seen. In some, obscure vacuolation was observed. They were much larger than the leucocytes. These, I have satisfied myself, are the amœbæ. On examining the muscular layer, no abnormality was found except infiltration by granulation cells although here and there fragmentation of the muscle was encountered. On examining the mucous and submucous coats of the small intestine the vessels of the latter were found to be very much engorged (Plate 3, *f*). Numerous collections of granulation cells were found, but I failed to discover any cell having the appearance of an amœba. In the mucous layer, the mucous glands were seen to be embedded in a cellular infiltration. The portion of the glands abutting on the lumen was found obliterated and it had been replaced by a cellular infiltration and by hæmorrhagic patches. On carefully examining the infiltrated mucous membrane with the oil-immersion lens, I failed to find any cell resembling an amœba except among the hæmorrhagic patches. In these hæmorrhages are found big amœboid cells surrounded by erythrocytes. Plate 2, fig 2, is a representation of one of these patches as seen under the oil-immersion lens.

On studying sections of that portion of the large intestine which was found embedded in the abscess cavity, no trace of the mucous coat could be distinguished. A considerable portion of the muscular coat had been replaced by granulation cells embedded among which were found engorged capillaries. In one of the vessels I found numerous amœbæ collected within the lumen of the capillary in which were also found leucocytes, red blood corpuscles, and remnants of the shed endothelial lining of the vessels. This finding of the amœbæ inside the capillaries indicates the way the amœbæ spread through the tissues, that is, by the vascular system.

The question now arises as to whether this amœba is a new one. It is evident from the description given above that it cannot by any means be classed as *Entamœba histolytica*. As no other amœba has been proved to be pathogenic, the one under consideration is then a new pathogenic species. It is necessary, however, to compare the structure of this amœba with other species that have been found in human fæces by other observers. I need not refer, in this connection, to the large number of ill-defined species of amœba described by writers who did not use modern staining methods. The only types to which this amœba has resemblance are *Vahlkampfia* (*Amœba*) *limax* and *Entamœba nana*. *Vahlkampfia limax* found in human fæces as described by Wenyon(6) is a very small organism that does not measure more than 10 $\mu$ in diameter. Furthermore, the nucleus is situated centrally and is spherical. There is no differentiation between the ectoplasm and the endoplasm so far as can be seen. It then becomes necessary to compare this species with *Entamœba nana,* for this variety has been found recently to be very common throughout the world. It has been reported from Egypt, England, the United States,(3) the Philippine Islands, and other places. Most of those who have reported on it are agreed that it is nonpathogenic. From the description of the species as given by Kofoid, Kornhauser, and Swezy(4) we find that the nucleus has a massive karyosome that is situated on one side of the nuclear membrane, the remainder of the nucleus being empty. *Entamœba nana,* as described by Dobell and Jepps, (2) has a fragmented karyosome. These descriptions differ from the nuclear structure of the amœba under consideration. Furthermore, the characteristic distinction between the ectoplasm and endoplasm, which is a very prominent character in my amœba, has not been found in the other two amœbæ. Moreover, these being nonpathogenic, they cannot be the same species as this one.

As no cyst has been found by me, it is not possible for me to compare these amœbæ with respect to their encysted forms.

## RÉSUMÉ AND CONCLUSIONS

I have discovered an amœba causing fatal dysenteric lesions in man and differing from *Entamœba histolytica* in the following essential points: (1) The nucleus is massive—not karyosomic; (2) there is marked distinction between ectoplasm and endoplasm; (3) chromidia are absent.

The lesions caused by this organism differ from those familiar in dysentery of *Entamœba histolytica* origin, in that the small intestine is attacked—a phenomenon heretofore absolutely unknown in dysentery of entamœbic origin. Furthermore, the peculiar peritoneal involvement is a unique thing.

The amœba differs in important morphological details from both *Entamœba nana* and *Vahlkampfia* (*Amœba*) *limax*.

In asserting that this amœba is a new species I suffer under the difficulty that I have to draw my deduction from a single case. To ascertain whether it is a purely local variety hitherto unobserved, I have studied many permanent preparations that I have made from numerous stools from dysentery patients as well as from pus from liver abscesses, which I have had the opportunity to examine during the past six years that I have been studying the intestinal protozoa. In no specimen studied could I find any amœba showing a nuclear or cytoplasmic structure similar to that of the amœba I have found. Other workers in India who have studied the structure of amœbæ found in human fæces and who have used recent staining methods, among them Cragg(1) and Knowles and Cole, do not mention having come across any variety of amœba other than *Entamœba histolytica* and *E. coli*.

Therefore, it seems evident that this is a new species. The next question is, to what genus it should be assigned. According to Schaudinn and to Doflein, the genus *Entamœba* is characterized by a parasitic mode of life, movement by "Lappige" [lappenförmige?] pseudopodia and by transmission to other hosts in cysts. This amœba can then be classified under the genus, although I have not been able to demonstrate the encysted stage.

I designate this amœba *Entamœba paradysenteria* sp. nov. This name, of course, may later be dropped if the organism is determined to be a species already described.

REFERENCES

(1) CRAGG, F. M. A contribution to our knowledge of Entamoeba coli. Indian Journ. Med. Res. **26** (1919) 462.

(2) DOBELL, C., and JEPPS, M. W. On the three common intestinal entamœbæ of man and their differential diagnosis. Brit. Med. Journ. **2** (1917) 607.

(3) KOFOID, C., A., KORNHAUSER, S. I.; and PLATE, J. T. Intestinal parasites in overseas and home service troops of the U. S. Army. Journ. Am. Med. Assoc. **72** (1919) 1721.

(4) KOFOID, C. A.; KORNHAUSER, S. I.; and SWEZY, OLIVE. Criterions for distinguishing the endamœba of amebiasis from other organisms. Arch. Int. Med. **24** (1919) 35.

(5) SCHAUDINN, FRITZ R. Untersuchungen über die Fortpflanzung einiger Rhizopoden. Arb. a. d. Kaiserl. Ges.-Amt. **19**[8] (1903) 547.

(6) WENYON, C. M. The common intestinal protozoa of man. Lancet **2** (1915) 1173.

(7) WENYON, C. M., and O'CONNOR, F. W. Journ. Roy. Army Med. Corps. **28** (1917) 346.

# ILLUSTRATIONS

[Drawings by B. L. Das.]

PLATE 1

Smears from pus. The specimens were fixed in a moist state in aqueous picric acid solution and stained by Dobell's modified iron hæmotoxylin stain. Drawn under 1/12 inch apochromatic lens with No. 6 eyepiece.

FIG. 1. Type of nucleus. Figs. 1, 3, and 6 show types of nuclei that are predominant in smears taken from pus found in the abscess or from ulcers in the small and in the large intestines. Note the striking difference between these nuclei and that of *E. histolytica*.

2. A rounded nucleus. The oval body in the right corner is probably the remnant of an engulfed erythrocyte.
3. An amœba in the motile stage: *n* is the nucleus, the other bodies are cell inclusions.
4. An amœba in resting condition.
5. An amœba, showing the characteristic nucleus.
6. An amœba, showing a rounded nucleus with a layer of clear cytoplasm surrounding it. The elongated body at the left corner is a remnant of an engulfed erythrocyte.
7. An amœba with dense rounded nucleus. This appearance is not common.
8. Two amœbæ of markedly different sizes. The cytoplasm shows well-marked vacuolation.
9. Two amœbæ with well-marked ectoplasm.
10. An amœba in the motile stage, showing marked differentiation between ectoplasm and endoplasm.
11. An amœba with the nucleus showing a central body like a karyosome; this is probaly an artefact.
12. An amœba in motile condition.
13. An amœba showing no differentiated ectoplasm; *a*, the nucleus; *b*, a cell inclusion.

PLATE 2

FIG. 1. Part of an amœba drawn under 1/12 inch apochromatic lens and No. 18 eyepiece; *n* is the nucleus; the characteristic unstained patch is clearly seen. The protoplasm is vacuolated. *e* is the ectosarc.

2. A section of tissue drawn under 1/12 inch oil-immersion lens and No. 6 eyepiece. *a*, a capillary vessel containing three amœbæ; *b*, an amœba in the tissue.

PLATE 3

A section of tissue drawn under low power. *a*, the exudation on the surface of the peritoneum. *b*, the subperitoneal tissue. *c*, points to longitudinal muscular coat. *d*, to transverse muscular coat. *e*, points to submucous tissue. *f*, points to a hæmorrhagic patch on the surface of the mucous membrane. This portion has been drawn under 1/12 inch oil-immersion lens and No. 6 eyepiece in Plate 2, fig. 2.

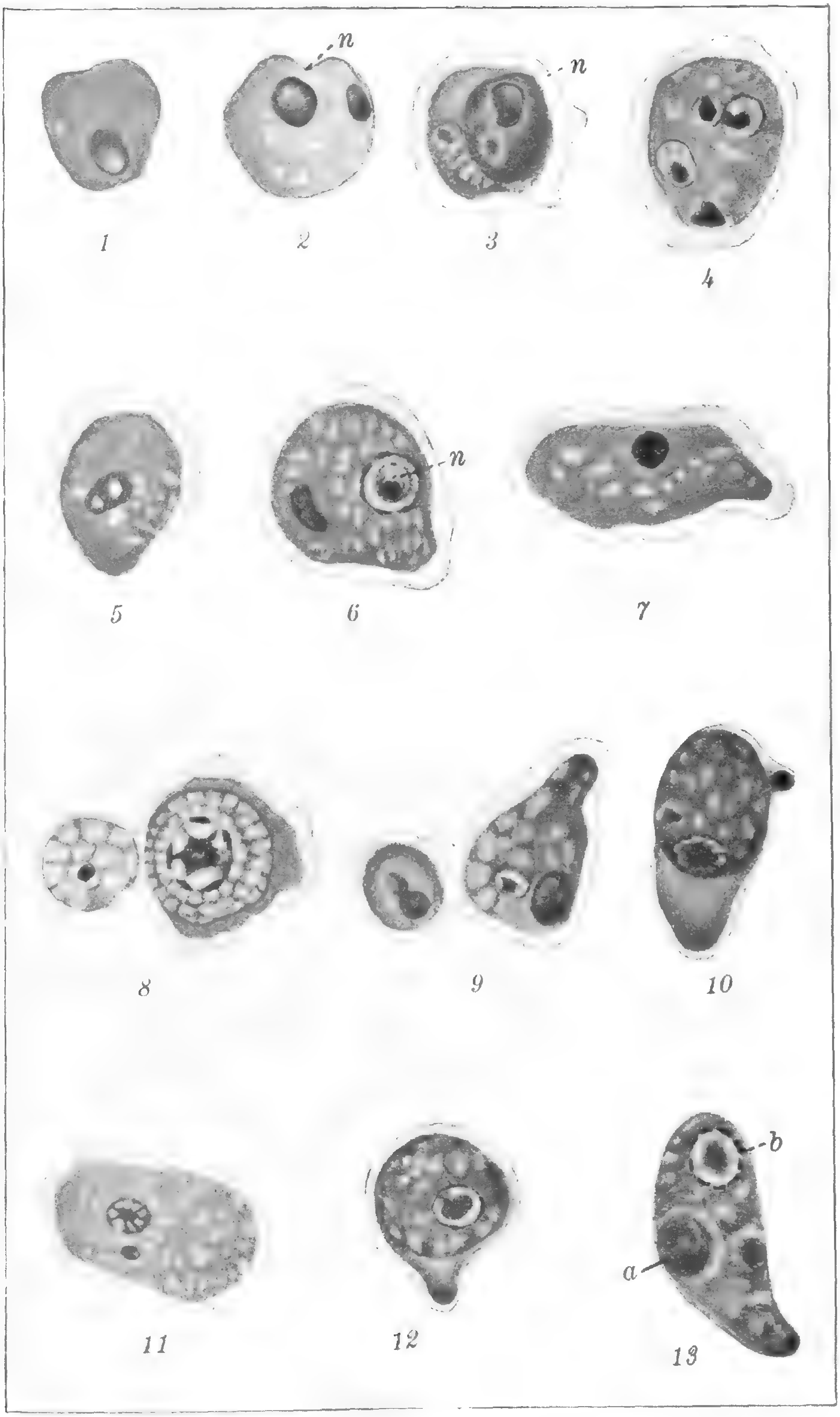


PLATE 1. VARIOUS STAGES OF THE AMŒBA.

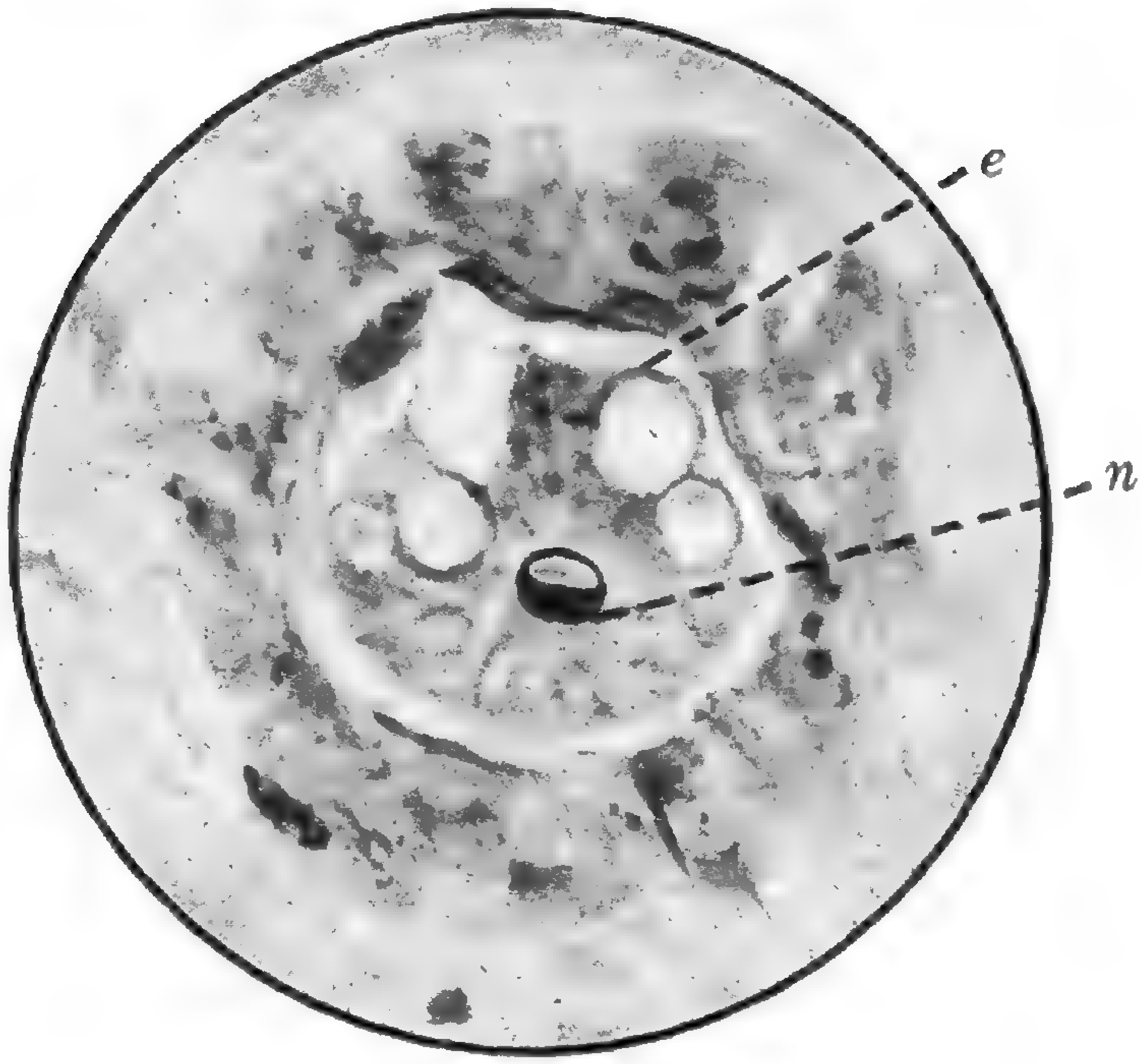


Fig. 1. Part of an amœba.

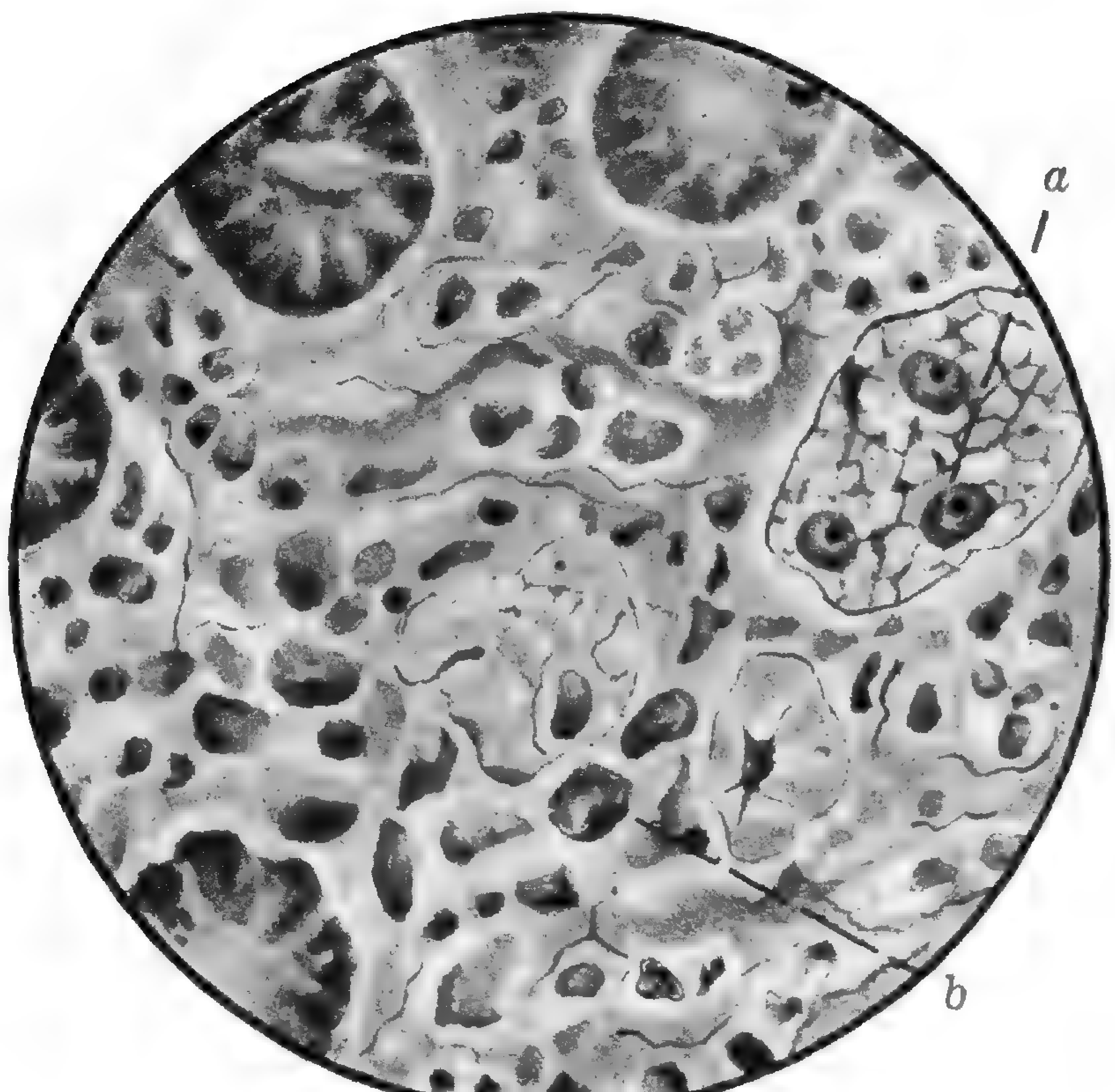


Fig. 2. A section of tissue containing amœbæ.

PLATE 2


PLATE 3. A SECTION OF TISSUE UNDER LOW POWER.

# THE UTILIZATION OF WASTE MOLASSES IN THE PHILIPPINE ISLANDS

## WITH SPECIAL REFERENCE TO THE HACIENDAS OF NEGROS [1]

By H. J. CARSTEN

*Of the Bureau of Science Sugar Laboratory, Iloilo*

The disposal of waste molasses has been a troublesome problem to the modern sugar manufacturer; and on Negros Island, with centrals springing up like toadstools, the difficulty is enhanced.

Several schemes have been tried and, although they have helped to some extent, it has been practically impossible up to the present time to use all of the molasses produced. The following are some of the ways in which this product has been used:

1. As fuel, in conjunction with bagasse.
2. As fuel, separately.
3. For the manufacture of alcohol and the recovery of potash from the waste.
4. The solidification of molasses.
5. Manufacture of cattle feed or easily transportable molasses.
6. The manufacture of fuel gas.
7. The manufacture of sugar by the Steffen process, as modified by Battelle.
8. The manufacture of char and recovery of the potash.
9. The manufacture of acetate of lime.
10. The manufacture of glycerin by fermentation.

### 1. THE BURNING OF MOLASSES IN CONJUNCTION WITH BAGGASSE AS FUEL

The use of molasses as a fuel in conjunction with bagasse is limited. Certain mixtures of bagasse and molasses cause the formation of clinkers, which results in the burning of the grates. In most factories, where this practice was begun, it was later abandoned on account of the burning of the grates, damage to the brickwork, or because of the trouble encountered in cleaning the fire boxes.

### 2. THE BURNING OF MOLASSES SEPARATELY AS FUEL

Molasses has been used by itself as fuel. One of the methods was to spray it into the fire box under steam pressure. How-

[1] Received for publication, July 21, 1919.

ever, the steam needed for the spraying just about offset the extra steam obtained by the use of the molasses as a fuel.

Molasses has been burned in Steele ovens. In this process it is allowed to run over inclined plates, where it comes in direct contact with the hot gases from the fire. The molasses becomes charred on its way to the grates and, once ignited, maintains the fire. The gas created is often sent into the bagasse furnaces to be burned there. Sometimes the charred molasses is treated in a current of air and steam, making producer gas which is utilized for power.

When the molasses is burned by itself, it is of course possible to recover the potash. However, this process is profitable only when the factory uses the potash in the soil; a very high market price for potash could make this process profitable commercially.

In all burning processes, valuable materials are invariably lost; namely, sucrose, glucose, and fructose, which form about 55 per cent of the weight of the molasses.

### 3. THE MANUFACTURE OF ALCOHOL AND THE RECOVERY OF POTASH FROM THE WASTE

In the manufacture of alcohol the three substances sucrose, glucose, and fructose do not constitute waste because they are converted into alcohol. Eventually it is possible to recover the potash from the waste, so that all valuable materials in the molasses are recovered when it is used in making alcohol. This utilization of waste molasses is of especial interest at the present time, because alcohol, when properly denatured, becomes an economical fuel for farm tractors used in cane fields. It may be of interest to state here that many of the planter's troubles—such as rinderpest, shortage of labor, and delayed planting—can be avoided by the use of tractors.

On Negros Island the area available for sugar planting could produce, say, 500,000 tons a year; about 200,000 tons are produced at present. Estimating that 10 tons of cane will produce 1 ton of sugar, and that 1 acre will yield 20 tons of cane, 100,000 acres (about 40,350 hectares) will produce 200,000 tons of sugar. The molasses weight is about 25 per cent of the weight of the sugar produced; therefore, 200,000 tons of sugar would yield 50,000 tons of molasses which, at 12 pounds to the gallon, amounts to 8,333,333 gallons. Taking the high figure of 3 gallons of molasses to 1 gallon of alcohol at 180° proof, we find 2,777,777 gallons of alcohol as the possible yield from the waste molasses now produced yearly in Negros.

The gasoline consumed by an ordinary, light tractor is about 8 gallons per hectare for plowing. For the yearly crop on Negros Island, the plowing would take 322,800 gallons of gasoline which at 10 pesos per case, amounts to 322,800 pesos.

In estimating the quantity of alcohol that an engine equipped for alcohol consumption would require to plow 40,350 hectares of land, it is said that: [2]

Although the heat value of alcohol per pound is comparatively small (11.178 B. T. U. per pound), yet on account of the heaviness as a vapour, and the small volume of air required to burn it compared with benzine and gasoline, it yields 89.2 B. T. U. per cubic foot of mixture at 60° F. and atmospheric pressure. Moreover, the products of combustion are six and one half times greater than the volume of the unburnt mixture, with corresponding increase in the pressure developed. There is thus, thermally considered, not very much to choose between alcohol and gasoline; alcohol is, in fact, an excellent fuel for suitably designed internal-combustion engines, and is largely used in Germany where its production is encouraged by the Government; in 1904 the price of alcohol in Germany was only 30 cents per gallon when purchased in large bulk.

Alcohol engines require larger carburettors, piping, and valves than are necessary when gasoline is used. As the latent heat of alcohol much exceeds that of petrol, especially when water is present in any considerable proportion, it is also necessary to jacket the carburettor with hot water or exhaust gas and to heat the ingoing air to about 350° F. in order to ensure complete vaporization. The cylinder jacket water should also be kept at nearly 212° F.; too cool a cylinder results in imperfect combustion of the mixture, because of the formation of acetic acid, aldehyde, etc., instead of carbon dioxide and water only, causing loss of efficiency and the corrosion of internal parts. Starting up from cold is a special difficulty with alcohol, and engines are usually started with gasoline, the alcohol being turned on when everything is well warmed up.

Some engines are arranged so as to start and stop on gasoline; in this way any traces of water or acid from the alcohol are cleared out of the cylinders and passages, during the last few revolutions of the engine, and corrosion of parts is thus avoided.

Test on a 14 H. P. "Locomobile" alcohol engine of 8.28" bore and 11.8" stroke made by Prof. E. Meyer in 1901, showed a brake thermal efficiency of 24 per cent, using alcohol containing about 13 per cent water. The volume ratio of compression was 5.9. The cylinder jacket water temperature was maintained at 208° F. The engine ran at 280 revolutions per minute and developed 13.9 C. H. P. [B. H. P. ?] at full load.

In round numbers, it takes 1.85 pounds of alcohol as against 1 pound of gasoline. Assuming the gasoline specific gravity to be 0.72, 1 pound of gasoline would equal 0.167 gallons; and 1.85 pounds of alcohol with a specific gravity of 0.8228 would equal 0.268 gallon. Therefore, 322,800 gallons of gasoline will develop the same number of British thermal units as 517,771

[2] From the Engineer's Year Book for 1916.

gallons of alcohol, the quantity necessary to plow one crop in Negros.

Taking the value of gasoline at 10 pesos per 10 gallons, the value of the alcohol per gallon would be 61.79 centavos. At the present market price of gasoline, 14 pesos per case, the value of the alcohol would be 86.5 centavos per gallon.

Obviously, plowing will not require the consumption of the total yearly yield of 2,777,777 gallons of alcohol; but harrowing and cultivating can also be done by power developed from alcohol, except when the cane gets too tall, when such work will have to be done by man and animal power or, possibly, by a specially designed machine. The amount of alcohol available is at least four times that required for plowing. Even if two plowings and one harrowing should require three times the quantity (517,771 gallons) the total consumption would amount to 1,553,313 gallons and there would still be a surplus of 1,224,464 gallons of residual alcohol.

On a plantation where tractors are used the alcohol left after plowing and harrowing might be utilized in motor-driven pumps for irrigating, for conducting water to the factory, and, where practicable, also for fluming the cane. These operations would surely consume the entire alcohol output. Should there still be a surplus some of it could be used in the manufacture of ether, which is now imported into the Islands. Moreover, the residual alcohol could be marketed at a profit for other purposes.

Apart from the production of alcohol, carbon dioxide can be produced, which is of value, both as a commercial product and as a necessary reagent in the manufacture of white sugar. The weight of carbon dioxide produced is much less than the quantity of alcohol made, but it is sufficient to care for overliming in the manufacture of white sugar. The recovery of carbon dioxide necessitates extra expenditure and will be of value to the sugar manufacturer only if he wishes to make "plantation white sugar" for the immediate market. The waste from the alcohol manufacture, when evaporated either in the sun or by special devices, is valuable as a fertilizer. However, this waste, because of its potash content, might more profitably be returned to the soil from which it was taken.

### 4. THE SOLIDIFICATION OF MOLASSES

In solidification, the molasses is evaporated in a specially constructed pan to such a density that it will solidify after discharge.

There are several ways of handling this hardened product. Formerly it was discharged into special gunny sacks which were first half filled, then allowed to cool, and later filled. Another method is to drop the material upon a cement floor, cut it into strips with shovels, roll it up and put it into sacks. The last-named method is advantageous in that no damage is done to other cargo in shipping, and that expensive barrels are not needed.

In shipping straight molasses to places where a good price is obtainable, the Negros planter is handicapped by the cost of containers and by the shipping distance. Small quantities are being transported in tank ships to the new distillery in Iloilo.

When molasses is sold for 5 centavos per gallon, as has been done, the buyer has no guarantee as to the available contents. Of course, contracts are made, stipulating a minimum content of solids for the molasses, expressed as Brix. However, a true basis of value—one that would give satisfaction to both buyer and seller—is the total sugar content, for which 52 per cent may be chosen as a good standard. Only the total sugar content determines the value of the molasses to the distiller. If the molasses is to be used for cattle feed, an expression of its nutritive value should form the basis of valuation. I fully understand that at first it will be difficult to convince the average distiller of this necessity; but, eventually, all distillers will have to use more scientific methods in their plants.

Further, solidified molasses can be used by possible buyers for any purpose for which ordinary molasses is used.

If a plant for solidifying molasses were erected near a shipping point such as Pulupandan, Negros, and run coöperatively by all centrals interested, shipping would be facilitated, and dependence upon the Manila or the Iloilo markets avoided by shipping direct to the Pacific Coast or to Europe, as is now being done with sugar. Some of the smaller centrals, now going out of existence because of the competition of the larger ones, could then use their evaporating plants and pans for solidifying molasses.

Relative to this subject I herewith give a free translation of an article by Beumer,[3] as follows:

Since the possibility exists of a renewed demand for solidified molasses, and since a few factories have already closed contracts for the coming season for its delivery it seems timely to give some information as to its manufacture.

[3] Beumer, A. H. T., Archief. voor de Suikerindustrie in Nederlandsch Indië 27 (1919) 932–936.

There are still factories that do not feel justified in making this product, due to the cost of manufacture and the care that must be exercised; also because the possibility exists that the product may be refused, or that it may have to be sold for as much as 20 centavos a picul less than the price agreed upon. Even at the reduced price the factories are usually glad to get rid of the sticky stuff.

At the same time, no by-product of the sugar factory has been so neglected, while as a matter of fact no other product is so easily manufactured, and even so low a market value as 48 to 52 centavos per picul would warrant its manufacture. However, the manufacturer who contemplates starting in this business must first abandon the idea that his old pans, etc., which are no longer fit for the manufacture of sugar proper, constitute all the equipment he will require in the new enterprise.

To begin with, he will need a first-class vacuum pump, one that will give a vacuum of at least 69 centimeters. If there is no such pump on the grounds, or should its purchase be considered unnecessary, troubles are bound to result and disappointment is sure. It is better to sell the molasses in liquid form than to try to solidify it without a good pump.

Preferably a separate pump should be used for the molasses pan, for the following reasons:

(1) To obtain a constant vacuum not influenced by the opening or shutting of the valves on the other pans.

(2) Because the vapors attack the walls of the juice catchers and pipe lines to such an extent that cases have occurred in which after two seasons these had to be replaced. If this happens when a separate pump is used—and it is less likely to occur when a high vacuum is maintained—it will be necessary to repair only the line for the molasses pan; while, otherwise, perhaps the whole piping system for the central condensation would have to be repaired or even renewed.

The best way is to insure a connection between the vacuum line for the molasses station and the other pans, but separated by a tight-shutting valve or a blind flange. This plan offers the advantage that, if the central pump breaks down, the material can be worked off in the pans with the other vacuum pump, though obviously that process is bound to be slow.

The pan itself must be a coil pan, in which the coils are neither too close together nor too close to the wall of the pan. This will facilitate discharge and will give better circulation.

If both pump and pan conform to these specifications, one can be sure of a good product, and the total time of boiling should not exceed between six and seven hours for a strike of 135 hectoliters, inclusive of cooling.

Water circulation in separate iron coils is then unnecessary, and even undesirable, since the iron coils harm the circulation between the steam coils.

Boiling can be finished in five hours, if necessary, with live steam, and it is recommended that the finished molasses be allowed to cool for from one to two hours under vacuum. A pan with a capacity of 135 hectoliters is sufficient for a grinding capacity of 14,000 piculs[4] of cane, and will handle all the molasses, taking into account the time required for

[4] The Javanese picul is about 1 pound less than the common Philippine picul.—H. J. C.

dropping the strike and refilling. This then means that three strikes can be obtained in twenty-four hours, resulting in an effective pan capacity of about 65 per cent.

With a good installation no expensive supervision is required. Several factories have changed from Chinese to Javanese sugar boilers at about f15.00 [5] per month.

One of the best grades of solidified molasses was seen at the Krian Sugar Factory where one of the head sugar boilers supervised the molasses station. The vacuum maintained in this place was 71 centimeters (mercury vacuum meter).

When a manufacturer starts to make solidified molasses with his poor, outworn apparatus, he usually meets with disastrous results, especially when the market is low. Then he will resort to various methods for the purpose of marketing the product, anyway; such methods, however, do not prove profitable. The principal tricks tried are:

1. Adding milk of lime during boiling. This never improves the product; on the contrary, it makes the solidified molasses even more hygroscopical than it would be without lime.
2. Water cooling. Some benefit results from this expedient. A more intensive cooling is obtained in the pan and, therefore, there will be less foaming in the containers later.
3. Dropping the strike on a cement floor and, therefore, not discharging directly into containers. The molasses is allowed to spread over the floor to a thickness of about 6 to 7 centimeters. After cooling it is cut with a sharp shovel into strips, which are afterward rolled up and put into the containers.
4. Filling the containers about half full and filling them up later from a following boiling.

As already stated, these tricks only lead to disappointment, the chief object being to prevent foaming in the containers. This causes a red coloration of the product, and also causes the contents of the full containers to be under weight.

*Containers.*—As is well known, the solidified molasses is shipped in sacks (made of buri or other light material) containing a maximum net weight of 1.5 piculs while 1 picul is the minimum weight allowable.

With the containers used at present no fear need be entertained that the net weight would not be at least 1 picul if the product is of good quality; more than the maximum weight is usual. It is important that the containers be well filled, since if they are not trouble is often experienced with the buyers. Good quality product sinks well into the sacks, and filling up is never necessary.

The "glangsiemat," which is a special variety of sack made of a material like rough straw, has a special bottom, and at the top is a loose piece of the same material to cover the solidified molasses.

If rattan is to be used it will be better to buy round rattan and split it, as the commercial split rattan is often of a bad quality and breaks easily. The rattan should be soaked in water the night before using.

[5] In the Philippines the wages would be about 40 pesos per month.—H. J. C.

The use of bagasse to fill up the container often causes complaints from the buyers, and it is better to fill up with loose pieces of solidified molasses.

*Production cost.*[6]—The net weight per container is assumed to be 1.40 piculs. The total cost, at 36.5 centavos per picul, comes to about 50 centavos per container.

Assuming that a factory has a capacity of 14,000 piculs of cane, or an average of 300 piculs of solidified molasses, and that there are needed one sugar boiler at 1.50 pesos per day; two helpers at 80 centavos per day; for the weighing, one capataz at 1.00 peso per day; and six men at 80 centavos per day, then the expense per day is 8.90 pesos, or roughly 2.96 centavos per picul for wages, and therefore solidified molasses could be made at a cost of 39.46 centavos per picul. This figure does not include cost of fuel, maintenance, depreciation, and transportation to the harbor.

Assuming the cost of fuel to be 5 centavos per picul, then the production cost comes to 44.46 centavos, exclusive of the other items mentioned above. Cost of transportation, especially, will vary for the different factories—it is less in the Philippine Islands than in Java. Nevertheless, at a market value of 60 centavos per picul, the manufacture of this product would still be profitable.

I wish to call particular attention once more to the fact that good results can only be obtained with proper installation in which the most important factor is a vacuum of at least 69 centimeters. If such a vacuum cannot be obtained, it would be wiser not to make this product.

This whole paper contains nothing new, but since troubles are continually found with this manufacturing process, it may prove of value to those interested.

An analysis of this material is as follows:

| | |
|---|---|
| Brix | 104.9 |
| Solids | 99.8 |
| Polarization | 40.4 |
| Apparent purity | 38.5 |

From this analysis it will be seen that the resulting material is about one and a quarter times as compact as the original molasses, which has a Brix of about 80°.

At a value for molasses of, say, 5 centavos per gallon at the factory, the value per picul, or 12 gallons, would be 60 centavos; due to concentration 15 gallons per picul would be required, which would bring the value up to 75 centavos per picul. This does not take into consideration the ease of handling and shipping, as compared with the unsolidified product.

## 5. THE MANUFACTURE OF CATTLE FEED OR EASILY TRANSPORTABLE MOLASSES

It is a well-recognized fact that molasses is a valuable cattle feed. Animals have to get used to it, but like it once they are

[6] Adapted to Philippine Island methods.—H. J. C.

compelled to eat it. In Hawaii a certain quantity of the molasses is being fed with cane tops to the plantation horses, but this use of it alone is not sufficient to warrant its utilization as horse feed. In Negros also it is used for this purpose, but here again the molasses cannot all be used up. A market must be found for it.

From the standpoint of the central, it would appear to be a good plan to work all of the molasses up into the cattle feed called molassecuite, which is a solid product. Even if there is no sale for it as a cattle feed, molasses in this form can be easily handled, and shipped either to distillers or to others who may be able to use it. Textbooks give the method of manufacture, so that I need not repeat it here. The material can be blocked for shipment, and the amount of fine bagasse used in making it is very small, about 6 per cent of all the bagasse or, approximately, 1.4 per cent of the cane. In block form the need of expensive containers is eliminated and it keeps well if properly prepared. Prinsen Geerligs gives the following analyses of such material shipped from Java to Liverpool, analyses having been made four months after it was manufactured:

| | Java. | Liverpool. |
|---|---|---|
| Total sugar | 45.28 | 45.55 |
| Moisture | 15.79 | 15.15 |
| Fatty substance | 0.12 | 0.50 |
| Albumen | 2.88 | 2.75 |
| Ash | 8.29 | 8.45 |
| Fiber | 16.06 | [a] 5.53 |
| Undetermined | [b] 11.58 | 22.07 |
| | 100.00 | 100.00 |

[a] Indigestible fiber. [b] Digestible fiber and undetermined.

Sections 4 and 5 of this paper show that both uses discussed therein are equally well adapted to give the sugar manufacturer an extra profit, thereby reducing the cost of manufacture of the primary product. Since that discussed in section 5 eliminates the need of an extra pan, it appears to be the better of the two. The molassecuite contains 25 parts fine bagasse to 75 parts of molasses.

### 6. THE MANUFACTURE OF FUEL GAS

The manufacture, from molasses, of gas for illuminating or heating purposes has been tried many times; but the cost of fuel is considerable, and the resulting gas contains so much carbon dioxide and other substances that much lime is required for its purification. Furthermore, the gas has very little illuminating power. Perhaps where potash is manufactured from wood, this utilization of molasses would be advantageous, since the wood has to be burned or dry distilled anyway.

### 7. THE MANUFACTURE OF SUGAR BY THE STEFFEN PROCESS, AS MODIFIED BY BATTELLE

This has been tried in Hawaii. In the process the glucose is all or partially destroyed by heating the original juice or molasses in an alkaline medium, and then handling the resulting product exactly as in the Steffen process, making saccharate, which is used partly to neutralize the juice. The method requires many changes from and additions to that used in existing raw-sugar factories and, so far as I know, has not yet proved successful in practice. The principle is correct, and I should like to see it given a trial on a large scale, in order to settle definitely the question of its usefulness. Of course, in this process a valuable material is lost, namely, glucose; and it remains for the individual centrals to decide whether they derive more profit from the sale of sugar and molasses separately or from going into the recovery process with a subsequent gain in sugar but loss of the glucose—and of the molasses, of course.

### 8. THE MANUFACTURE OF CHAR AND RECOVERY OF THE POTASH

The molasses is dry distilled and the resulting material leached to obtain the potash. The char is ground and used in fields. It helps heat absorption and makes a compact soil more porous. The process of leaching out the potash salts is described in any work on the manufacture of this material, and I need not repeat it here.

### 9. THE MANUFACTURE OF ACETATE OF LIME

This utilization of molasses has been carried on for some time in a large plant in Brisbane, Australia. The molasses is first subjected to acetic fermentation in the ordinary way. The resulting acetic acid solution is then distilled until it is practically free from acetic acid. The vapors (or the condensed acetic acid solution) are run into milk of lime, forming acetate of lime solution. This solution is evaporated to the consistence of a massecuite and is then spun in centrifugals to dry, while the mother liquid is used for the dilution of fresh molasses. The resulting material is shipped to the cordite factory at Maryborough, where the lime acetate is subjected to dry distillation to obtain the acetone, which is used as an admixture and solvent in the manufacture of cordite. I have no data as to the value of acetate of lime, and hope to write about this later, when I have better information.

## 10. THE MANUFACTURE OF GLYCERIN BY FERMENTATION [7]

In Germany large quantities of glycerin were obtained through the fermentation of sugar. In that country sufficient sodium sulphite was added to the fermenting liquid to produce the degree of alkalinity that would cause the yeast cells to perform their work as well as to propagate.

The test was made as follows: One kilogram of sugar and 400 grams of sulphite were dissolved in 10 liters of water. To the feed yeast there were added ammonium sulphate, sodium phosphate, and a little potassium salt. After some hours carbon dioxide was given off, and after about two days all the sugar was fermented.

The liquid filtered from the yeast cells contained water, alcohol, aldehyde, glycerin, and salts. Salts were precipitated and a good grade of glycerin was obtained by distillation. The sole difficulty was that the decomposition of glycerin caused the formation of trimethylglycol. After much experimentation this difficulty was overcome, and the process is now practicable.

It is a peculiar fact that, with a higher percentage of sulphite, the quantity of glycerin and aldehyde increases, while that of alcohol and carbon dioxide becomes less. This seems to involve a double reaction. It has been noticed that a large quantity of a neutral salt, even if reacting alkaline, increases the glycerin fermentation. Apparently a specific reaction must be ascribed to the sulphite.

In the United States the fermentation process has been made practicable by John R. Eoff.[8] The greatest quantities of glycerin were obtained from sugar solutions containing 5 per cent sodium carbonate, which is not all added at once. He found that a less quantity decreased production, and a larger stopped fermentation. Sodium hydroxide, potassium hydroxide, or borax can be used, but sodium carbonate is cheapest. The sodium carbonate was added when fermentation had well started, and as much as possible while fermentation was in progress; the earlier it was added the greater the glycerin product. To maintain yeast growth, ammonium chloride was added.

The best temperature is between 30° and 32° C.; a higher temperature caused decomposition of alcohol and glycerin, while a lower temperature decreased production.

[7] Deutsche Zuckerindustrie, May 16, 1919; see also Journ. Soc. Chem. Ind. 38 (1919) 175R–177R.

[8] Journ. Soc. Chem. Ind. 38 (1919) 176R.

173259——6

The best concentration of sugar was found to be between 17 and 20 grams per 100 cubic centimeters. It was proved that after fermentation was complete 20 to 25 per cent of the sugar was changed into glycerin and the remainder into alcohol and carbon dioxide.

With soda added in sufficient quantity a thick precipitate formed, gas formation stopped, and the yeast lay dormant for a while. The precipitate then disappeared and fermentation proceeded again. Better results were obtained by adding soda in crystal form than in the form of a solution. A process used commercially is the following:

Yeast is seeded with a platinum loop into 150 cubic centimeters of sterile melon juice, and left to ferment. Of this liquid 15 cubic centimeters are then added to 150 cubic centimeters of the same sterile juice. After fermentation 75 cubic centimeters are added to 800 cubic centimeters of molasses solution (specific gravity 1.085=20.4 Brix). As soon as fermentation is proceeding strongly, 3 grams of soda ash are added and the whole shaken. After further fermentation this liquid is added to 2 gallons of molasses solution (as above) and this mixture is treated at the right time with soda ash in the same proportion as given above. When fermentation is complete the 2 gallons are added to 40 gallons of a solution made up as follows:

To 425 gallons molasses of 1.085 at 25° C., 8 pounds of ammonium chloride were added; the liquid was sterilized and brought with sterile water to original density. This solution contained 16.85 per cent of sugar (therefore purity is 82.6). Temperature was maintained at 30° C. and after five days fermentation was completed. Analysis of the liquid showed the following:

| | Per cent. |
|---|---|
| Glycerin | 3.1 |
| Alcohol | 6.75 |
| Sugar | 0.86 |

Alkalinity 3.6 grams sodium carbonate per 100 cubic centimeters.

Purification of the liquid was as follows: 3,200 pounds were neutralized with sulphuric acid, and 12 gallons ferrous sulphate solution added. After heating to the boiling point, milk of lime was added until there was an excess of lime, and the liquid was boiled by steam for a half hour. It was then filtered through a press and the press cake steamed. The addition of ferrous sulphate and lime was repeated, and after filtration the alkalinity brought back to 0.2 per cent sodium carbonate by adding soda ash. The filtrate was then evaporated in a vacuum pan to a thick sirup, which contained between 30 and 35 per cent of glycerin.

It was then distilled, and 50 pounds of glycerin were obtained, roughly half the quantity present in the fermented liquid.

The carbonaceous ash is high, but by a second distillation a good product was obtained. The glycerin can be nitrated normally.

A second treatment with lime and ferrous sulphate will give no results, and a part of the glycerin will be lost in any case.

A production of 5.5 to 6 pounds per hundredweight of molasses may be expected by this process.

# CERTAIN CARDIAC REFLEX SYMPTOMS DUE TO DISTURBANCES OF REMOTE ORGANS [1]

By A. G. Sison

*Of the Department of Medicine, College of Medicine and Surgery, University of the Philippines*

Palpitation, chest oppression, and precordial distress are some of the cardiac symptoms that the laity regards as the usual indications of cardiac disease. I may venture to say that physicians are not exempt from this belief and are often disposed toward diagnosticating a cardiac affection the moment a patient describes one or all three of the above symptoms.

It is surprising to me how frequently the said symptoms are preceded by others that are physically just as troublesome and distressing, and yet those suffering from them do not consult a physician until the advent of the above-mentioned symptoms referable to the heart. The probable reason is that the laity is frequently under the impression that, in all likelihood, sudden death is the ordinary outcome in any affection in which the heart might be involved. They hear of many sudden deaths that were attributed to cardiac failure, and doubtless in many instances rightly so; but it is no less true that there are very many individuals who are suffering from symptoms seemingly of cardiac origin, and yet the most careful examination and observation fail to indicate that this organ is at fault. On the contrary, the heart is normal, while the seat of the trouble is in some neighboring or remote organ or organs that may exert some influence on the heart in various ways—sometimes by nervous connection, at other times by mechanical influences or by the presence of certain toxic substances acting either on the nervous mechanism of the heart or directly on the heart itself, and in still other instances we have the intervention of a psychical factor to explain the appearance of the cardiac reflex symptoms.

A person who has the slightest suspicion that his heart is diseased is often haunted by the fear of impending death. His mind is focussed, as it were, entirely on his heart. He not only feels and counts his pulse, but watches for the slightest symp-

[1] Read before the Manila Medical Society, December, 1916.

tom that may be attributed to his heart. If this attitude continues for some time, by some sort of autosuggestion he suffers from many imaginary symptoms and in time may become a real sufferer from the so-called brain storm.

A typical picture is that of a middle-aged married man, who came to see me one midnight, complaining of symptoms supposed to be of cardiac origin, as he had been told by the physicians he had previously seen. His symptoms were marked palpitation, chest oppression, and precordial distress accompanied by psychic phenomena of anxiety and fear of sudden death. The man was rather nervous and inhaled every once in a while from a small bottle containing ether. While in the paroxysm of his attack I examined him physically and, to my great surprise, in spite of all of his symptoms—palpitation, difficulty of breathing, chest oppression, and precordial distress—I found the heart entirely normal. There was no abnormal pulsation, the apex beat was in normal place, the cardiac outline was normal, and there were very good cardiac sounds. The pulse was not over 60 per minute; it was very regular in rhythm and fairly good in tension and in volume. The blood pressure, by the Erlanger apparatus, was 120 millimeters of mercury. On examining his abdomen I found distinct tenderness in the epigastrium, in the region of the stomach. In trying to get a complete anamnesis, I found the patient had been suffering for a long time before he had had any cardiac manifestations. There were symptoms referable to the stomach, such as nausea and vomiting occasionally in the morning; heaviness and sometimes pain in the stomach after meals; frequent eructation of gas followed by amelioration of the stomach symptoms; and later on the cardiac symptoms above referred to. His psychical symptoms did not appear until he was told that he was suffering from cardiac disease, and ever since his attacks have been growing more frequent and worse, for he realized then the supposed seriousness of his trouble.

The examination of his gastric contents disclosed a marked hypoacidity, and on X-ray examination there was marked gastroptosis. The lower border of the stomach was about 5 centimeters below the level of the umbilicus, and at the same time it was dilated. The patient was put under ordinary treatment for the stomach affection and was assured that his heart was entirely normal; he was counseled to take physical exercise. After a few weeks of such treatment the patient recovered completely.

The organs that might be affected and give rise to cardiac reflex symptoms are the gastrointestinal, the liver, and the genitalia. The probable relation between the latter and the heart is exclusively psychic in character.

The cardiac symptoms observed in diseases of the digestive organs (namely, of the gastrointestinal and the liver) must not be hastily taken as such without previous consideration of the possibility that the latter organs may be frequently affected as the result of a primary cardiac affection.

Another fact that is well established and that has been known for a long time is that dyspeptic conditions produce disturbances of the heart, especially in children.[2] The disturbance sometimes consists in acceleration, but much more frequently in retardation and irregularity of the rhythm. Similar manifestation is observed in adults, in whom, however, palpitation with tachycardia is much more frequent than bradycardia and sometimes irregularity of rhythm. These symptoms are often associated with anomalies of digestion, constipation, flatulence, eructations, and distention.

Although the primary causes of these disturbances are found in diseases of the stomach, intestines, and liver, there is no doubt that they are not due to any lesion in the abdomen, for a variety of conditions may give rise to the same sequence in the heart; on the other hand, the same cause by no means produces symptoms of equal severity in the same individual, or even in different ones. This makes it evident that the trouble lies in alterations in the central nervous system or in the intrinsic nerves of the heart itself or in both; at all events, nervousness is a very important factor in the development of these conditions.

Potain, as quoted by Krehl,[3] has stated that the abdominal diseases giving rise to cardiac disturbances are not grave in character, and Krehl entirely agrees with him. Potain further says that the milder affections of the gastrointestinal tract and of the liver are the ones that are apt to be associated with cardiac reflex symptoms. He mentions that in certain cases there is even absence of dyspeptic processes, and the mere ingestion of certain foods, entirely harmless in other individuals, is followed by the above-mentioned cardiac symptoms. He is inclined to believe in some chronic irritation of the peripheral nerves and the existence of an extreme anomaly of the nerves, either in the central nervous system or in the heart.

[2] Krehl, Diseases of the Heart in Nothnagel's Encyclopedia of Practical Medicine, 789.

[3] Loc. cit.

I cannot agree entirely with the view taken by Krehl in regard to the absence of the dyspeptic processes, when he mentions certain foods that are harmless to certain individuals and harmful to others with supposed anomalies of the nerves, either in the central nervous system or in the heart. When there is disturbance in the function of the organs of digestion, we have necessarily to admit that they are no longer working as they do in normal individuals. On the other hand, the supposition of nervous constitution, or of anomaly of the nerves in the central nervous system or in the heart, is equivalent to the admission of two preëxisting conditions—one, the phenomenon of idiosyncrasy, which is congenital in character and consequently must not be considered in such cases of cardiac reflex symptoms observed in adults; the other, some nervous affection of unknown character manifesting itself in conjunction with certain cardiac symptoms. This does not appear to be tenable and is contrary to the mass of facts and evidence we have on this question.

One important fact in eliminating the possibility that such cardiac symptoms may be due to cardiac affections is that special demands on the heart muscle, such as active bodily exercise, are entirely without evil effect and are indeed well borne.

Certain explanations are offered to establish the connection between the cardiac symptoms and the abnormal conditions in the abdomen. Krehl takes the intoxication theory as the most probable and the one most in accord with modern views. This theory still lacks foundation, for we do not know what the toxic substances are; all we know is that special forms of dyspepsia are particularly apt to bring on disturbances of heart action. Another possibility advanced by Potain is that the disturbances are due to reflexes from the abdominal organs acting on the heart through the pneumogastric nerve. There is undeniably a great similarity between many of these heart symptoms and the symptoms produced by irritation of the vagus. There are, besides, two other things that support this view. One is that irritation in a part of this nerve is especially apt to be propagated to other portions of the nerves, as has been shown by numerous observations. For example, we have the case of vagotony or marked sensitiveness of the vagus to any stimulant; secondly, other symptoms are observed after gastric disturbances, which cannot be regarded as due to anything but reflex irritation of fibers of the pneumogastric nerve—that is, reflex irritation through the lungs. Finally, the rapid disappearance of the symptoms, or distinct amelioration of them after copious belching, points toward reflex irritation. In such cases the disturbance of the heart action can be due only to direct irritation of the stomach, either mechanical or toxic in nature. It is possible that a stomach greatly distended with gas may directly affect the heart through the diaphragm, but this mode of irritation is probably unimportant, for in many cases there is absolutely no tympany of the gastrointestinal tract. I have seen, however, cases of stomach dilatation (atonic dilatation) confirmed by X-ray, in which the cardiac reflex symptoms were very prominent, that make me think that this atonic dilatation accompanied by distention was the main factor; as, once the accumulated gas was expelled by eructation, almost immediate amelioration of the symptoms was felt by the patient, in spite of the persistent dilatation of the stomach.

Anginoid pain in the precordial region radiating to the left arm and resembling in its character the pain felt in angina pectoris may occasionally occur. This anginoid pain coming in paroxysmal attacks is differentiated from true angina pectoris by the greater number of attacks experienced by the patient. In true angina the patient rarely survives many attacks, while the attacks of anginoid pain that I call spurious angina may recur many times without endangering the life of the patient. Exercise is of no importance whatever as an etiologic factor, the ingestion of food being the exciting factor, as a rule. As I have mentioned, these anginoid attacks are never dangerous, and they disappear when the affection of the stomach has been relieved.

A few words in regard to the effect of stomach diseases on the action of the heart. The pulse may be increased or decreased; it is usually increased in stomach affection complicated by fever, and sometimes when there is marked distention. This acts as a mechanical stimulant and, as it were, irritates the heart. It is usually decreased in chronic cases where, on account of the duration of the disease, there is more or less impairment of general nutrition and more or less general weakness; it is observed in ulcers and in ectasy.

Besides the changes in rate, disturbances of rhythm may occur, such as arrhythmia or irregularity of heart action, though not frequently.

In liver affections bradycardia is one of the characteristic features observed in the heart, and occasionally there is chest oppression. These symptoms, strange to say, are observed in acute cases of short duration; but in chronic cases the bradycardia usually disappears, either on account of the reduction of the amount of bile acids in the blood or because the heart becomes accustomed to their effect. If we take into consideration the usual appearance of gastric complications accompanying catarrhal conditions in the bile ducts, it is difficult to say whether these cardiac manifestations are the result of liver disease or of the stomach complication.

The factors that may be responsible for the production of cardiac reflex symptoms due to disturbance of remote organs may be grouped under the following heads: (1) Mechanical, (2) chemical, (3) psychic.

*Mechanical factors.*—The mechanical theory may be explained in two ways; either by encroachment of the distended stomach on the space occupied by the heart, or by the mechanical irritation of the nerve endings on the wall of the stomach, produced by the stretching of the wall. Mere overloading is not always followed by such symptoms; they may be present without dilatation or distention.

*Chemical factors.*—The chemical causes may be endogenous or exogenous. The endogenous may be toxic substances which originated in a perverted digestion, or may be certain internal glandular secretions or homones which, when present in the blood in larger amounts than normal, may disturb the heart action without necessarily causing pathological change in the organ. They may act, however, in manifold ways on the central nervous system, on the intrinsic nervous mechanism of the heart, or on the heart muscle itself.

The exogenous chemicals, like nicotin, atropin, and others, have no place here, as we are discussing only disturbances in the body itself that are accompanied by cardiac reflex symptoms.

*Psychic factors.*—The psychic factors are probably ultimately chemical. We have the experiments of Cannon and De la Paz [4] about the increase of epinephrin in a cat by psychic excitement, as rage, fright, etc. The subject of emotion is a complicated one.

In conclusion, no one of these factors is the only one responsible for the production of the cardiac reflex symptoms; but all or one of them may play some rôle in producing the symptoms in individual cases, and in many instances one or all of them may help to cause the cardiac syndrome designated under the name of cardiac reflex symptoms.

[4] Cannon, W. B. and De la Paz, D., Emotional stimulation of adrenal secretion, Am. Journ. Physiol. 28 (1911) 64–70.

# CLINICAL OBSERVATION ON EXPERIMENTAL STARVATION IN HUMAN BEINGS[1]

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The physical changes that can be demonstrated clinically in experimental starvation are the effect of certain metabolic changes that occur in the organs of the individual or of the animal undergoing starvation.

Fasting may be partial or total. In the former no food is ingested, but the quantity of water permitted is unlimited, or else a specified daily amount is given; while in the latter, neither food nor water is taken. From the clinical viewpoint there is practically no difference, as the physical changes noted in either form are identical, differing only in degree, not in character.

For a better understanding of the structural changes in some of the organs, let me describe the features of metabolism during starvation. The elimination of nitrogenous katabolic products begins to diminish in the early days of fasting, and there will be a period, if the fasting is continued, in which the said elimination will reach a constant level. This fact apparently indicates that the protein katabolism is stimulated during the early period of fasting. Voit, in explaining this constant increase of protein katabolism, established the distinction between "morphotic" and "circulating" tissue protein in the body. The morphotic protein, or the more stable nitrogenous component of the cells, undergoes only slight disintegration in the ordinary course of metabolism, while circulating protein is largely used during the early days of fasting. The fall in nitrogen excretion in the later period of fasting is explained by Voit as being caused by a stage of metabolism in which other tissue components are destroyed in lieu of the residual and more stable morphotic protein.

When the starvation is prolonged beyond the limit of tolerance or resistance of the tissues of the body, there is observed an ante-mortem rise of nitrogenous elimination, which is a sign

[1] Read before the Manila Medical Society, December, 1916.

of impending death. This sudden rise in nitrogenous output is explained by some as having been produced by a sudden disintegration of the body cells because of the improper nutritive conditions to which they are finally subjected.[2] During the enhanced nitrogenous katabolism during fasting, there is observed a loss of weight, as the body is then living on its own tissues. The usual loss of body weight per day is on the average 1 kilogram, more or less.

My observations were made upon five individuals, one American and four Filipinos. The American was over 30 years of age, and the four Filipinos were under 30 years. The period of longest observation was on the American, who fasted for several periods during one hundred eighty-seven days. In the intervals of fasting he was permitted a liberal diet.

My observations on the four Filipinos covered a period of over three months. In all of them the form of fasting was of the mixed type. At the beginning there was a gradual diminution of the number of calories of food taken during twenty-four hours. The American, who is a physician, had previously undergone several experimental fasts in the United States, so he was more accustomed to the tests and was able to endure rather stricter partial fasting for a number of days with a limited amount of water during twenty-four hours. The four Filipinos were University students, who offered themselves as subjects for the experiment.

The system used in these experiments consisted of a general physical examination previous to the experiment, with recording of the weight in kilograms and also the blood pressure.

After the commencement of the fast, physical examination was made daily, with careful record of the results. Examination of the blood (hæmoglobin estimation and cell count) was made during the progress of the experiment, including the blood pressure. The results that were obtained from my observations are the following:

With the continuous loss of weight there were observed some distinct physical changes. There was a marked diminution of the panniculus adiposus or the subcutaneous tissue, especially in the face and abdomen. The normal relations of some viscera, both abdominal and thoracic, with the external structure was disturbed. These viscera are the lungs and heart in the thorax, and the liver, spleen, and intestines in the abdomen.

[2] Hawk, in Modern Medicine, Lea & Febiger, Philadelphia 2 (1914) 606.

The lungs during absolute starvation yielded a hyper-resonant or vesiculo-tympanitic percussion note throughout, probably due to marked loss of water in the lung tissue.

The heart was diminished in outline in both diameters, due either to the increased resonance of the lungs, which may possibly affect the area of dullness of the heart, or to a diminution in size of the organ through the loss mainly of water and partly of the pericardial fat. Other observers speak of a very slight change in the size of the heart, and they believe the organ is scarcely affected by starvation, in the sense that its size is but slightly diminished. Should this be the case, slight diminution ought not to be followed by distinct contraction of cardiac outline. My findings, however, give such diminution. Probably the vesiculo-tympanitic sound detected in the lungs in this case may have to do with the apparent contraction of cardiac dullness.

There was a lowering of blood pressure of from 10 to 15 millimeters, and the pulse was slow—from 10 to 15 beats less than normal—volume large, tension low, rhythm regular. The red blood cell count was below normal, hæmoglobin normal. There was, however, a distinct decrease of leucocytes, about 4,000 being found per cubic millimeter.

The liver was distinctly diminished in outline by percussion. The upper boundary was on the level of the upper border of the sixth rib, and the lower one about 3 centimeters above the costal margin.

The spleen was also diminished in size by percussion. The most probable explanation of this diminution in size is due, on the one hand, to loss of water in the liver and spleen tissues, giving rise to actual diminution in size of both organs; and, on the other hand, the adventitious vesiculo-tympanitic note of the lungs may have something to do in exaggerating the said diminution.

On inspection of the abdomen the peristaltic movement of the intestines was distinctly seen, with borborygmi at times, felt by palpation.

There is a sweetish odor, like that of acetone, to the breath.

For the sake of comparison I shall quote an experiment of prolonged fasting carried on very recently in the National Nutritional Laboratory in Boston, by Benedict.[3] The length of the fast was thirty-one days.

> The subject * * * took only 900 c. c. of distilled water a day by mouth. He lost 13.25 kg., which was 21 per cent. of his normal weight.

[3] Prolonged fasting, Journ. Am. Med. Assoc. 65 (1915) 956.

This is in accord with the results of other fasts. Succi lost 25.6 per cent. of his body weight in a forty-day fast. A dog fasting 117 days lost 62.9 per cent. of the initial weight. He was fed, regained his original weight, starved 111 days, and lost 53 per cent. of his weight. Luciani, who controlled the forty-day fast of Succi in Florence, has assumed that there is a mathematical relationship between the loss per day and the length of the fast. Benedict, however, has shown that this does not hold for human beings. He regards the weight loss as due to two factors: First, tissue is oxidized to supply material for a maintenance of body activities. Second, there is a loss of preformed water, that is, the water in the oxidized tissues. This water is lost more rapidly during the first days of a fast because there is greater tissue disintegration. This metabolic activity decreases for the reason that the subject becomes less inclined to do muscular work; he conserves his energy. He even clothes himself more heavily in order to preserve the body heat. Weight loss during a fast is decreased by the drinking of large amounts of water. It has been assumed that this water acts as a nutrient and spares the tissues. It is surprising to note that the loss of water as insensible perspiration, in Benedict's subject, varied between 371 and 691 gm. per twenty-four hours. In an individual on a full diet, this amount is much higher.

The Berlin investigations on Cetti, a professional faster, describe the "irritable heart of fasting."[4]

The pulse rate is supposedly much increased on even slight exertion. Benedict's work does not confirm this. On the contrary, the amplitude of the pulse rate, that is, the difference between the pulse rate at first as compared with the rate when active, became less and less as the fast progressed.[5] Accompanying this was a progressive decrease in the blood pressure, a maximum fall of 30 mm. of mercury resulting. There was also an actual decrease of 3 cm. in the width of the heart. These findings have been reported in other investigations, and are probably due to a decreased peripheral resistance.[6] When, at the conclusion of the fast, food is again taken, the usual pulse amplitude returns and the blood pressure soon rises to normal. From this work it is claimed that the pulse rate may be used as a legitimate index to metabolism.

Numerous changes have been reported as occurring in the blood of fasting subjects, among these a marked increase in the number of red cells. Benedict found chiefly an early rise of polynuclear leukocytes, and an increase in the blood acidity. The leukocytosis is apparently of little importance, since the leukocytes are the most sensitive of the blood cells, and respond to such stimuli as a meal or a cold bath. Their number fell to normal after the first few days of the fast. The blood acidity, from a study of the alveolar air, was found to increase markedly on the second and again on the fourteenth day of the fast, and remained at this high level throughout.

[4] This was never observed in any of my cases; on the contrary, there was sluggishness of the heart action as is shown by the diminution of pulse rate per minute during the progress of fasting.—A. G. S.

[5] My results are like those of Benedict on this point. After slight exertion the ordinary reaction, manifested by a rise in pulse rate, is lacking during fasting.—A. G. S.

[6] I have already mentioned the explanations that I am inclined to give for such diminution in cardiac dullness.—A. G. S.

When the fast was broken, it fell to normal. The hemoglobin and the total quantity of blood remained constant.

During the first days of the fast, more heat came from the glycogen that was burned than from the protein so used. Since glycogen burns most easily, it was rapidly drawn on and the available supply quickly depleted. From the first to the third day, from 10 to 16 per cent. of the heat was derived from glycogen. From the third to the thirteenth day, from 1 to 3 per cent was so obtained. The combustion of glycogen ceased after this time. As one would expect, fat eventually becomes the chief source of heat. In normal catabolism, fat is burned completely the end products being carbon dioxid and water; but in some pathologic conditions and in inanition, fat combustion is defective, and certain partially oxidized substances known as acetone bodies are produced and excreted chiefly in the urine. The clinical significance of this phenomenon is well known. These acetone bodies were present in the urine throughout the latter part of the experiment. The concentration of alkali necessary for their combustion greatly exceeds that which can be tolerated by the body.

Indicative of the so-called acidosis that occurs during starvation, besides the acetone bodies, the urine contains a large number of organic and inorganic acid radicals. Thus chlorin, phosphorus pentoxid, sulphur trioxid, and oxybutyric and other fatty acids are found. An albuminuria with hyaline and a few granular casts may also occur, but clears up after the fast is broken.

From a study of the oxygen consumption, the carbon dioxid excretion, the pulse rate and the temperature, one may conclude that there is a parallelism between these activities and the metabolism, and that the body acts as a unit irrespective of its state of nutrition.

With the foregoing results there are certain thoughts that force themselves as a corollary to our observations. Knowing the changes that occur after starvation, it is but logical to suppose that in certain diseases of long duration, mainly those on which the incidence of inanition is a necessary sequela or a concomitant condition that may arise therefrom, the train of pathological phenomena known as morbid anatomy of such diseases must be associated with those that are rather the effect of inanition. Now the question that suggests itself is: Are all of the physical findings on examination, ante- and post-mortem, the result of the disease per se, or are they accompanied by those that are produced by inanition, if it accompanies the disease? In spite of our knowledge of the morbid anatomy of many clinical entities, as well as their physical manifestations during their course, there still remains a little probability that this may have a part in the making up of some of the symptoms, physical findings, and morbid anatomy of many diseases in which there is a greater or less degree of starvation accompanying the course of the disease. Going a little further, some of the complications and sequelæ, while not directly caused by starvation, might indirectly be influenced by it. Should this be the case, it is not pretentious to predict that the more we become acquainted with the actual changes that occur in starvation, the more we shall have to correct our views regarding the morbid anatomy and the clinical manifestations of certain diseases. We have to draw a dividing line in describing the clinical and pathological manifestations by establishing those that are the result of starvation and those that are the effect of the disease itself, just as we have to distinguish the ante-mortem changes produced by disease from those that are the result of post-mortem changes.

The final solution of the problem lies in the domain of chemical pathology, which still is sadly neglected. There is hope, however, that this branch of medical science will become one of our greatest assets.

# REVIEWS

**The Medical Report of the | Rice Expedition to Brazil | by | W. T. Councilman, M. D. | and | R. A. Lambert, M. D. | from the school of tropical medicine | Harvard University | Cambridge | Harvard University Press | London | Humphrey Milford | Oxford University Press | 1918 | Cloth, i–vi + 3–126 pp.**

**The Diseases | of Infants and | Children | by | J. P. Crozer Griffith, M. D., Ph. D. | [6 lines of titles] | with 436 illustrations | including 20 plates in colors | Volume I, pp. 1–885 including index | Volume II, pp. 1–657 including index | Philadelphia and London | W. B. Saunders Company | 1919 | Cloth, $16 net.**

### PREFACE

It has been the effort of the author in the following pages to present a review of the subject of medical pediatrics, as complete as seemed desirable without attempting to make it encyclopedic. Inclusion is made of such subjects in surgery and the special branches with the recognition of which physicians treating the diseases of children should be more or less familiar. While endeavoring to embody the results of his own experience through many years of contact with disease in children, he has also made free use of the numerous excellent text-books on the subject, including the valuable contributions by American authors, and of home and foreign pediatric journal-literature. To all these authors he would here acknowledge his indebtedness.

In the course of his own reading he has found quotations from medical authorities of much impaired service unless accompanied by references to the places of publication, thus rendering possible the consulting of the originals. With the feeling that others may share this sentiment, he has in footnote form given the references to literature whenever such quotations are used, believing that in this way the value of the book to many readers would be increased, while the footnote method interferes in no way with its usefulness to those others who are not interested in this line of research.

Temperature-charts and photographic and other illustrations have been reproduced freely, generally accompanied by brief synopses of the histories of the cases, without which their value would be much lessened. These are orginal or unpublished except in the instances where none such were obtainable, or where superior ones were found in the publications of other writers. Acknowledgment has naturally been made in every case.

Throughout the text-book the metric and the English systems of measurements have been used together, putting in parentheses in the terms of one the equivalents in the other. The statistics quoted from any author have been given in the system employed by him, and the corresponding figures in the other then placed in parentheses. The equivalent values are largely those found in the tables of the United States Pharmacopœia. Ounces are respectively avoirdupois or liquid measure, except in designating the doses of solid medicaments, when Troy ounces are used. Fractional amounts in grains, drams, cubic millimeters, cubic centimeters, and grams are omitted unless the quantities are small. Grams are assumed to be the equivalent of cubic centimeters, ignoring the specific gravity of many liquids, where the figures as given would not be absolutely correct. In the parentheses the abbreviations designating grams and cubic centimeters are omitted, the sense of the text making them unnecessary. An exception to the employment of both systems of measurement will be found in discussing the preparation of food in the artificial feeding of infants. Here only English measures are given, since the preparation must be made in conjunction with the graduated nursing-bottles and the liquid measures in common household use.

Numerous cross-references will be found throughout the work, thus calling attention to discussions of the subjects on other pages, which would otherwise be overlooked unless the index were consulted. Although every effort has been made to avoid inaccuracy of statements, and particularly of references, the author must expect to share the experience of others, that these will creep in to some extent.

The author has waived his own preferences in the matter, yielding to the desire of the publishers for uniformity in the system of spelling and of punctuation adopted throughout the numerous works upon medical subjects published by them.

**The | Medical Clinics | of | North America | November, 1919 | published bi-monthly by | W. B. Saunders Company | Philadelphia and London | Paper, pp. 551–847, $12 per clinic year; cloth, $16.**

The Mayo Clinic Number, Volume III, No. 3, contains the following papers:

**Report of a case of retinitis circinata associated with tuberculosis, by W. L. Benedict.**

# THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 17 NOVEMBER, 1920 No. 5

## STUDIES ON PHILIPPINE RUBIACEAE, IV

By ELMER D. MERRILL

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In this fourth paper of the series [1] sixty-two new species are proposed in the genera *Gynochthodes, Hedyotis, Ixora, Morinda, Mussaenda, Ophiorrhiza, Pavetta, Plectronia, Psychotria, Randia, Tarenna, Timonius, Urophyllum,* and *Williamsia.* In this series, including the present paper, about one hundred sixty new species have been described. In the present paper, as in its predecessors, notes on nomenclature have been included, in the present contribution such notes being confined to those species proposed under the generic designations *Webera, Tarenna, Pavetta,* and *Stylocoryna.* An attempt has been made to distribute these between the genera *Tarenna* and *Pavetta.*

### GYNOCHTHODES Blume

**GYNOCHTHODES MINDANAENSIS** sp. nov.

Frutex scandens, glaber, ramis ramulisque teretibus; foliis subcoriaceis, ellipticis ad oblongo-ellipticis, 6 ad 10 cm longis, utrinque subaequaliter angustatis, breviter acuminatis, basi acutis vel acuminatis, nervis utrinque circiter 6, tenuibus, reticulis obsoletis; inflorescentiis axillaribus, 2.5 ad 4 cm longis, 5- ad 9-floris, racemosis vel cymosis, vel umbellatis, calycis cupulatis, truncatis, 4 mm longis; corollae tubo 8.5 mm longo; fructibus late obovoideis, circiter 8 mm diametro, 4-locellatis.

A glabrous, woody vine, the branches and branchlets terete,

[1] Studies on Philippine Rubiaceae, I, Philip. Journ Sci. 8 (1913) Bot. 31–62; II, op. cit. 10 (1915) Bot. 99–144; III, op. cit. 12 (1917) Bot. 159–176.

reddish brown to nearly black when dry. Leaves subcoriaceous, elliptic to oblong-elliptic, black when dry, 6 to 10 cm long, 2 to 4.5 cm wide, subequally narrowed to the acute or acuminate base and to the short-acuminate apex; lateral nerves slender, about 6 on each side of the midrib, the reticulations obsolete; petioles 1.5 to 2.5 cm long; stipules truncate, about 1 mm long. Inflorescences axillary, peduncled, 2.5 to 4 cm long, the terminal parts of the branches supplied with more or less reduced leaves and forming an elongated leafy inflorescence. Flowers 5 to 9 in each inflorescence, their pedicels up to 5 mm in length, the uppermost inflorescence sometimes reduced to a fascicle, others racemose or umbellate, and others cymose. Calyx cup-shaped, glabrous, truncate, 4 mm long. Corolla-tube 8 to 9 mm long, glabrous externally, the lobes spreading, oblong-ovate, obtuse, inside very densely white-villous. Style about 8 mm long. Anthers 2.5 to 3 mm long, linear-oblong. Fruits broadly obovoid, about 8 mm long and wide, slightly 4-sulcate, longitudinally 4-celled, black when dry.

MINDANAO, Surigao Province, *Bur. Sci. 34677* (type), *34589 Ramos & Pascasio,* April and June, 1919, on ridges at the iron deposit on the northeast coast, altitude 460 to 680 meters.

This species is distinctly different from the other representatives of this genus and of the allied genus *Tetralopha,* differing in its vegetative and inflorescent characters. I am now of the opinion that *Tetralopha* cannot be retained as generically distinct from *Gynochthodes.*

## HEDYOTIS Linnaeus

### HEDYOTIS ATROPURPUREA sp nov.

Suffruticosa, erecta, circiter 1 m alta, parce ramosa, ramis obscure rotundato-angulatis sulcatisque, dense breviter et adpresse hirsutis; foliis ovatis ad oblongo-ovatis, utrinque scabris, coriaceis, usque ad 7 cm longis, acuminatis, basi acutis, in siccitate utrinque viridis, in vivo subtus et cum ramis inflorescentiisque atropurpureis; nervis primariis utrinque circiter 6, supra valde impressis, subtus perspicuis, curvato-adscendentibus; inflorescentiis terminalibus, paniculatis, pubescentibus, usque ad 18 cm longis, multifloris; floribus circiter 5 mm longis.

An erect, sparingly branched, suffrutescent plant, about 1 m high, prominently pubescent, the leaves scabrous. Branches 5 to 6 mm in diameter, obscurely rounded-angled, usually sulcate, the older parts brownish, nearly glabrous, the younger parts rather densely appressed-hirsute with short, greenish-olivaceous hairs. Leaves coriaceous, ovate to oblong-ovate, 5 to 7 cm long, 2.3 to 4 cm wide, green on both surfaces when dry, when fresh deep purple beneath as are the branches and inflorescences, brittle, base rounded, apex acuminate, both surfaces scabrous from the short, scattered, hispid hairs; lateral nerves about 6 on each side of the midrib, prominent, curved-ascending, anastomosing, deeply impressed on the upper surface, both surfaces somewhat bullate; petioles 6 to 13 mm long, pubescent; stipules triangular-ovate, acuminate, sparingly toothed, pubescent, about 5 mm long. Inflorescence a somewhat leafy terminal panicle up to 18 cm long, rather prominently pubescent, the lower branches subtended by somewhat reduced leaves. Flowers numerous, somewhat corymbosely crowded on the branchlets, about 5 mm long, 4-merous, their pedicels pubescent, 5 mm long or less, the subtending bracteoles linear-lanceolate, 1.5 mm long. Calyx 2 mm long, the tube ovoid, terete, 1 mm long, the teeth as long as the tube, narrowly ovate, obtuse to acute, 1 mm long. Corolla-tube 2 mm long, the lobes narrowly ovate, obtuse, 1.3 mm long, the throat villous inside.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28578 Ramos & Edaño*, May 7, 1917, on the forested summit of the mountain, altitude apparently about 1,000 meters.

This characteristic species is described by Ramos as having the stems, inflorescences, calyces, and the lower surface of its leaves dark-purple in color, but when dry the leaves are uniformly greenish on both surfaces. It is well characterized by its scabrous, ovate to oblong-ovate leaves, which are more or less bullate on both surfaces, its nerves deeply impressed on the upper surface and prominent beneath.

### HEDYOTIS BRACHYANTHA sp. nov.

Suffruticosa, erecta, glabra, circiter 1 m alta, parce ramosa, ramis teretibus, ramulis leviter sulcatis; foliis lanceolatis, chartaceis vel submembranaceis, usque ad 12 cm longis, in siccitate pallidis, utrinque concoloribus, perspicue acuminatis, apice leviter falcatis, basi acutis ad decurrento-acuminatis, saepe inaequilateralibus, nervis utrinque 6 ad 8, tenuibus, obscuris, arcuato-anastomosantibus, reticulis laxissimis, obscuris; inflorescentiis axillaribus, 1.5 ad 2 cm longis, pedunculatis, corymbosis, paucifloris; floribus circiter 3 mm longis.

An erect, sparingly branched, glabrous, smooth, suffrutescent plant, about 1 m high, the stems terete, grayish-brown, the branchlets somewhat sulcate. Leaves lanceolate, chartaceous or submembranaceous, 9 to 12 cm long, 2 to 3 cm wide, rather pale and of the same color on both surfaces when dry, smooth, shining, narrowed upward to the rather prominently and somewhat falcate acuminate apex, the base often inequilateral, acute or decurrent-acuminate; lateral nerves 6 to 8 on each side of the midrib, slender, not prominent, curved, arched-anastomosing, the reticulations obscure, very lax; petioles about 1 cm long; stipules broad, 2 mm long or less, truncate, terminated by 2, short, stout teeth, rarely by 1. Inflorescences strictly axillary, 1.5 to 2 cm long, few-flowered, peduncled, corymbose. Flowers 4-merous, about 3 mm long, their pedicels 3 mm long, the subtending bracteoles linear, 1 to 2 mm long. Calyx-tube obovoid, terete, about 1.5 mm long, the teeth oblong, obtuse, less than 1 mm long. Corolla-tube 0.8 mm long, glabrous or nearly so within, the lobes narrowly ovate, obtuse, 1.2 mm long, slightly pubescent on the median portion within. Capsules subellipsoid, 4 mm long, terete.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28769 Ramos & Edaño,* May 5, 1917, on forested slopes at medium altitudes.

In general appearance this species approximates *Hedyotis sibuyanensis* Elm., but differs especially in its strictly axillary, shorter inflorescences, shorter petioles, and much shorter flowers.

**HEDYOTIS CATANDUANENSIS** sp. nov.

Frutex glaber, ramis obtuse 4-angulatis; foliis ovatis ad oblongo-ovatis, membranaceis vel chartaceis, usque ad 13 cm longis, leviter acuminatis, basi rotundatis, nervis utrinque 7 vel 8, olivaceis, nitidis, reticulis laxis, tenuibus; stipulis 3-laciniatis, glabris; inflorescentiis terminalibus, foliaceis, ramis primariis usque ad 4 cm longis, capsulis obovoideis, circiter 2.5 mm longis.

A glabrous shrub, the branches obtusely 4-angled. Leaves ovate to oblong-ovate, membranaceous to chartaceous, brittle when dry, olivaceous, somewhat shining, smooth, 9 to 13 cm long, 4.5 to 6 cm wide, narrowed upward to the somewhat acuminate apex, the base rounded; lateral nerves 7 or 8 on each side of the midrib, slender, distinct, curved-ascending, anastomosing, the reticulations slender but rather distinct; petioles 1 to 1.5 cm long; stipules 3 to 5 mm long, deeply 3-cleft, glabrous. Inflorescences terminal, leafy, the nodes supplied with reduced, ovate, shortly sessile, somewhat cordate, 1.5 to 4 cm long leaves, the primary branches up to 4 cm in length, about as long as the internodes, the partial cymes 2 to 3 cm in diameter, the bracts oblong-lanceolate, up to 5 mm in length. Capsules obovoid, about 2.5 mm long, their pedicels 3 mm long or less, the persistent calyx-teeth oblong-lanceolate, acute or somewhat acuminate, about 2 mm long.

CATANDUANES, Mount Mariguidon, *Bur. Sci. 30443 Ramos,* November 17, 1917, on forested slopes.

This species is most closely allied to *Hedyotis caudata* Merr., from which it is readily distinguished by its larger leaves, which are not caudate-acuminate, and its entirely glabrous stipules.

**HEDYOTIS DIFFUSISSIMA** sp. nov.

Suffruticosa, erecta, glabra, 1 ad 1.5 m alta, ramis circiter 6 mm diametro, acute 4-angulatis vel anguste 4-alatis; foliis membranaceis, in siccitate obscure olivaceis, nitidis, oblongis ad oblongo-ellipticis, usque ad 16 cm longis, utrinque subaequaliter angustatis et acuminatis, nervis utrinque circiter 6, adscendentibus; inflorescentiis axillaribus, longissime pedunculatis, diffusissimis, usque ad 40 cm longis, laxis, floribus circiter 6 mm longis, tenuiter pedicellatis.

An erect, suffrutescent, slightly branched plant, 1 to 1.5 m high, glabrous throughout except the inside of the petals. Branches sharply 4-angled or narrowly 4-winged, dark-olivaceous when dry, smooth. Leaves membranaceous or at most chartaceous, in general oblong to oblong-elliptic, 11 to 16 cm long, 3 to 5.5 cm wide, dark-olivaceous and shining when dry, smooth, subequally narrowed to the acuminate base and apex, the apical acumen slender, acute; lateral nerves about 6 on each side of the midrib, prominent on the lower surface, curved, ascending; petioles about 2 cm long; stipules lanceolate to oblong-lanceolate, acuminate, margins irregularly lacerate, about 1.5 cm long. Panicles axillary, solitary, long-peduncled, lax, very diffuse, up to 40 cm in length, the primary branches few, the lower ones up to 12 cm in length, the peduncles up to 20 cm long and more or less 4-angled. Flowers comparatively few, white, 4-merous, about 6 mm long, the slender pedicels up to 1 cm in length, the bracteoles lanceolate, acuminate, about 2 mm long. Calyx-tube ovoid, somewhat 4-angled, 1.5 mm long, the lobes oblong-ovate, somewhat triangular, acute, keeled, 1.5 mm long. Corolla-tube 2 mm long, the lobes oblong-ovate, acute, 2.5 mm long, densely pubescent inside. Capsules ovoid, black when dry, 4 to 5 mm long.

LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28387 Fénix,* May 22, 1917, on rocky forested slopes, altitude about 1,000 meters.

This most characteristic species is readily distinguishable by its very lax, diffuse, long-peduncled, axillary panicles, which attain a total length of about 40 centimeters. It does not closely resemble any other species known to me.

**HEDYOTIS LAXIFLORA** sp. nov.

Frutex erectus, glaber, circiter 1 m alta, ramis diffusis, sulcatis vel 4-angulatis, elongatis; foliis oblongo-ovatis, chartaceis, glabris, acutis vel breviter acuminatis, basi acutis, usque ad 4 cm longis, nervis utrinque 4 vel 5, tenuibus; stipulis circiter 3 mm longis, rigidis, profunde 3-lobatis; inflorescentiis axillaribus, tenuibus, diffusis, paucifloris, 4 ad 5 cm longis; floribus circiter 7 mm longis; capsulis obovoideis, 4 mm longis.

An erect, glabrous, much-branched shrub, about 1 m high (*fide* Ramos), the branches elongated, diffuse, sulcate or 4-angled, rather slender, the main stem terete or very obscurely angled, smooth, dark-brownish to purplish-brown. Leaves oblong-ovate, chartaceous, glabrous, yellowish-green and slightly shining when dry, glabrous, smooth, 2 to 4 cm long, 10 to 18 mm wide, base acute, apex acute or slightly acuminate; lateral nerves 4 or 5 on each side of the midrib, slender, obscure; petioles 3 to 4 mm long; stipules rigid, about 3 mm long, deeply 3-lobed. Inflorescences axillary, solitary, numerous, diffuse, few-flowered, 4 to 5 cm long, the pedicels divaricately spreading; bracts linear-oblong, 3 to 4 mm long, the bracteoles much smaller. Corolla-tube about 3 mm long, glabrous externally, pubescent within, the lobes oblong-ovate, about 3.5 mm long, puberulent within. Calyx-lobes oblong, subacute, 1.5 mm long. Capsule obovoid, 4 mm long.

CATANDUANES, Mount Mariguidon, *Bur. Sci. 30303 Ramos*, November 25, 1917, in forested ravines, altitude about 400 meters.

This characteristic species is probably as near *Hedyotis microphylla* Merr. as any other species, but is not closely allied to it. It is well characterized by being entirely glabrous; by its diffuse branches; its rather small leaves; and its diffuse, solitary, axillary, numerous, few-flowered inflorescences.

**HEDYOTIS LONGIPEDUNCULATA** sp. nov.

Frutex erectus, glaber, ramis ramulisque acute 4-angulatis; foliis chartaceis, oblongo-ovatis, usque ad 15 cm longis, laevis, nitidis, subolivaceis, subtus pallidioribus, utrinque leviter acuminatis, nervis utrinque 5 ad 7, vix prominulis, adscendentibus; stipulis oblongo-ovatis, acuminatis, laciniatis, circiter 6 mm longis; cymis axillaribus, solitariis, longe pedunculatis, 8 ad 12 cm longis, ramis paucis, circiter 2 cm longis, fructibus breviter pedicellatis, circiter 3 mm longis.

An erect, glabrous shrub, the branches and branchlets acutely 4-angled. Leaves chartaceous, oblong-ovate, subolivaceous when dry, shining, the lower surface paler than the upper, 11 to 15 cm long, 2.5 to 5.5 cm wide, subequally narrowed to the slightly acuminate base and apex, or the latter merely acute, smooth; lateral nerves 5 to 7 on each side of the midrib, distinct, ascending, scarcely projecting, not at all impressed on the upper surface, the reticulations obsolete or nearly so; petioles 1.5 to 3 cm long; stipules oblong-ovate, acuminate, laciniate, about 6 mm long. Cymes axillary, solitary, long-peduncled, 8 to 12 cm long, the peduncular parts 6 to 8 cm in length; primary branches few, verticillately arranged, about 2 cm long, the capsules somewhat crowded at the ends of the branches, their pedicels 2 to 3 mm long; bracts oblong, subacute, about 6 mm long. Capsules obovoid, about 3 mm long, the persistent calyx-teeth ovate, subacute, about 3 mm in length.

CATANDUANES, in forests along the Santo Domingo River, *Bur. Sci. 30551 Ramos*, December 3, 1917.

This species is well characterized by its acutely angled branches and branchlets, its relatively large leaves, and its long-peduncled axillary inflorescences. It somewhat resembles *Hedyotis fruticulosa* Volkens, of the Caroline Islands and, among the Philippine species, is probably closest to *Hedyotis phanerophlebia* Merr.; from both of these it differs radically in its vegetative and inflorescent characters.

**HEDYOTIS OLIGANTHA** sp. nov.

Herba parva, prostrata vel adscendens, parce ramosa, 10 ad 15 cm longa, subglabra, ramis tenuibus, 4-angulatis, glabris; foliis oblongo-lanceolatis ad anguste lanceolatis, oppositis, glabris vel minutissime scaberulis, usque ad 1.5 cm longis et 3 mm latis, sessilibus, basi angustatis, cum stipulis adnatis, acutis vel acuminatis, subtus pallidioribus, nervis lateralibus obsoletis; stipulis cupulatis, truncatis, leviter pubescentibus, margine tenuiter laciniatis, laciniis 3 vel 4, tenuibus, scaberulis, 2 ad 4 mm longis; floribus solitariis, sessilibus, axillaribus, corollae tubo gracile, 4 mm longo, lobis oblongis, valde reflexis, 3 mm longis, intus ad basi villosissimis.

A small, prostrate or ascending, slender, sparingly branched, nearly glabrous perennial herb, the stems 10 to 15 cm long, slender, glabrous, 4-angled. Leaves opposite, glabrous or very minutely scaberulous, oblong-lanceolate to narrowly lanceolate, rather stiff, 1 to 1.5 cm long, 1.5 to 3 mm wide, the lower surface pale, the midrib distinct but the nerves and reticulations obsolete, the base narrowed and connate with the stipules, apex somewhat acuminate; stipules cupular, truncate, their margins with usually 3 or 4, slender, scabrid, 2 to 4 mm long teeth. Flowers axillary, sessile, solitary, white. Corolla-tube very slender, 4 mm long, the lobes oblong, 2.5 to 3 mm long, strongly recurved, densely villous inside near the base. Capsule oblong-obovate, somewhat angled, 3 mm long, the persistent calyx-lobes lanceolate, acuminate, 1.5 to 2 mm long.

LUZON, Rizal Province, Mount Susong Dalaga, *Bur. Sci. 29425 Ramos & Edaño* (type), August 2, 1917: Bataan Province, Limay, *Bur. Sci. 6180 Robinson,* August, 1908: Pampanga Province, Mount Arayat, *Merrill 4220,* September, 1905, on damp shaded banks in forests, altitude 300 to 900 meters.

This species belongs in the group with *Hedyotis tenelliflora* Blume, *H. nitida* W. & A., and *H. pinifolia* Wall., and is perhaps most closely allied to the second one, although very different from it in details. The very slender, elongated corolla-tube and the solitary flowers are characteristic.

**HEDYOTIS SCABERRIMA** sp. nov.

Frutex parvus, foliis utrinque valde scaberrimis, ramis primariis usque ad 60 cm longis; foliis membranaceis, fragilis, oblongo-ovatis, 8 ad 11 cm longis, apice acuminatis, nervis utrinque circiter 7, supra impressis, subtus prominulis, subtus ad costa villosis; petiolo villoso; stipulis 4 ad 5 mm longis, 7-laciniatis, laciniae 2.5 ad 3 mm longae; floribus numerosis, axillaribus, fasciculatis, confertis, corollae circiter 3 mm longae.

Apparently an undershrub, the branches at least 60 cm long, the leaves very rough on both surfaces with short rigid projections, branches somewhat 4-angled or distinctly sulcate, more or less villous with spreading hairs. Leaves membranaceous, brittle when dry, greenish olivaceous, oblong-ovate, 8 to 11 cm long, 3 to 4.5 cm wide, base rounded to acute or somewhat decurrent-acuminate, somewhat narrowed upward to the rather prominently acuminate apex, both surfaces hispid-scaberulous, the midrib beneath and the petiole densely villous with spreading white hairs; lateral nerves about 7 on each side of the midrib, slender, curved, ascending, projecting on the lower surface, impressed on the upper surface, the primary reticulations very lax, rather distinct on the upper surface, obscure beneath; petioles 5 to 8 mm long; stipules 4 to 5 mm long, divided into 7 linear laciniae, the upper 4 about 3 mm long, the lower ones somewhat shorter. Flowers in dense axillary fascicles about 1 cm in diameter, their pedicels 1 to 1.5 mm long. Calyx about 2 mm in diameter, the lobes 4, oblong, about 1 mm long. Corolla white, 3 mm long, glabrous, the lobes 4, oblong, reflexed, about 1.2 mm long. Capsule elliptic-obovoid, glabrous, about 2 mm long.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 30940 Ramos & Edaño,* May 27, 1918, in thickets along streams.

This species belongs in the group with *Hedyotis philippensis* (Willd.) Merr. and is closely allied to *H. asperrima* Merr. from which it is distinguished by its somewhat larger leaves, the midrib beneath and the petioles being rather densely white-villous, as well as by its different stipules. In *Hedyotis asperrima* the midrib beneath and the petioles are more or less scabrid, not villous, while the laciniae of the stipules are reduced to short lateral projections 1 mm long or less. Another differential character is that of the midrib and nerves which are not at all impressed in *Hedyotis asperrima* but which are conspicuously so in *H. scaberrima.*

### HEDYOTIS SIMPLEX sp. nov.

Species *H. rigidae* affinis. Suffrutex erectus, simplex, 40 ad 60 cm altus, caulibus vetustioribus teretibus glabris, junioribus sulcatis vel obscure angulatis, parcissime hirsutis; foliis chartaceis, lanceolatis ad oblongo-lanceolatis, usque ad 14 cm longis, glabris, nitidis, utrinque acuminatis vel basi acutis, nervis utrinque circiter 7, adscendentibus, distinctis; stipulis ovatis ad oblongo-ovatis, circiter 12 mm longis, acuminatis, margine leviter laceratis; inflorescentiis axillaribus, dense multifloris, subglobosis vel hemisphaericis, sub fructu 1 ad 1.5 cm diametro; fructibus globosis vel leviter obovoideis, circiter 2 mm diametro, parcissime hirsutis, calycis lobis oblongo-ovatis, obtusis, circiter 1.5 mm longis, leviter hirsutis.

An erect, unbranched undershrub, 40 to 60 cm high, the older stems terete, glabrous, up to 5 mm in diameter, the younger parts somewhat hirsute, sulcate or somewhat angled. Leaves chartaceous, lanceolate to oblong-lanceolate, somewhat olivaceous when dry, glabrous, shining, 9 to 14 cm long, 2 to 3.5 cm wide, subequally narrowed to the acute or acuminate base and to the rather slenderly acuminate apex; lateral nerves 7 on each side of the midrib, slender but distinct, ascending, obscurely anastomosing, the reticulations obscure; petioles 2 to 2.5 cm long; stipules ovate to oblong-ovate, prominently acuminate, thin, glabrous or sparingly hirsute, about 12 mm long, the margins somewhat lacerate. Inflorescences axillary, dense, many-flowered, in fruit forming globose or hemispheric masses 1 to 1.5 cm in diameter. Pedicels 1.5 to 2 mm long. Bracteoles linear-oblong, up to 4 mm in length, sparingly ciliate-hirsute. Capsules globose to somewhat obovoid, 2 mm long, sparingly hirsute, the persistent calyx-lobes oblong-ovate, obtuse, 1.5 mm long, somewhat hirsute.

CATANDUANES, in forests, *Bur. Sci. 30389* (type), *30242 Ramos*, November, 1917. BILIRAN, Mount Suiro, *Bur. Sci. 18914, 18745 McGregor*, June, 1914.

This species resembles *Hedyotis rigida* Miq. (*H. leucocarpa* Elm.), but is entirely different in habit, being an unbranched undershrub, with larger stipules and very numerous, sparingly hirsute, smaller fruits which are crowded in dense hemispheric to globose infructescences.

## IXORA Linnaeus

### IXORA LUZONIENSIS sp. nov.

Frutex 1 ad 2 m altus, glaber, ramis ramulisque teretibus vel ramulis leviter compressis; foliis lanceolatis ad oblongo-lanceolatis, chartaceis, usque ad 16 cm longis, in siccitate pallidis, nitidis, breviter petiolatis, apice acuminatis, basi angustatis, acutis; nervis lateralibus utrinque circiter 15, tenuibus, distinctis, arcuato-anastomosantibus; stipulis filiformibus, 7 ad 10 mm longis; infructescentiis terminalibus, circiter 3 cm longis, e basi ramosis; floribus ut videtur paucis; fructibus ovoideis, 6 ad 8 mm diametro.

A glabrous shrub 1 to 2 m high, the branches and branchlets terete or the latter slightly compressed, slender. Leaves lanceolate to oblong-lanceolate, chartaceous, pale and shining when dry, 11 to 16 cm long, 1.5 to 3 cm wide, narrowed upward to the acuminate apex and below to the acute base; primary lateral nerves about 15 on each side of the midrib, slender, distinct, spreading, arched-anastomosing; petioles about 2 mm long; stipules filiform, 7 to 10 mm long from a somewhat widened base. Infructescences terminal, about 3 cm long, branched from the base, the flowers apparently few, the pedicels 5 to 8 mm long, the branches few, spreading, the bracts linear-lanceolate, about 1 mm long. Fruits red, ovoid, 6 to 8 mm in diameter, brown to nearly black when dry.

LUZON, Cagayan Province, Pamplona, *Bur. Sci. 7420, 7481 p. p. Ramos,* March, 1909: Zambales Province, *Bur. Sci. 5045 Ramos,* December, 1907: Pangasinan Province, Mount San Isidro, Labrador, *Bur. Sci. 29956 Fénix* (type), November 4, 1917, in forests, altitude 350 to 400 meters.

The alliance of this species is undoubtedly with *Ixora sparsiflora* Elm., from which it is at once distinguished by its much narrower, entirely differently shaped leaves which are acute, not broad and cordate at the base. From *Ixora longistipula* Merr. it is at once distinguished by its entirely different inflorescences.

## MORINDA Linnaeus

### MORINDA CORIACEA sp. nov.

Frutex scandens, glaber, ramulis circiter 2 mm diametro, foliis crasse coriaceis, oblongis, 7 ad 11 cm longis, utrinque subaequaliter angustatis, basi acutis, apice obtuse acuminatis, nervis utrinque circiter 8, tenuibus, distinctis; fructibus solitariis vel paucis, globosis, circiter 12 mm diametro.

A woody, glabrous vine, the branches dark-colored when dry, the ultimate branchlets subterete, 2 mm in diameter or less. Leaves rather thickly coriaceous, oblong, 7 to 11 cm long, 1.8 to 3.5 cm wide, usually olivaceous and slightly shining when dry, subequally narrowed to the acute base and to the usually blunt-acuminate apex; lateral nerves about 8 on each side of the midrib, slender, rather distinct as are the primary reticulations; petioles 5 to 7 mm long; stipules somewhat sheathing, deciduous, about 4 mm long. Fruits terminal, solitary, in pairs or sometimes threes, umbellately arranged, globose, rather many-seeded, about 12 mm in diameter, yellow when fresh, black or brown when dry, their pedicels usually about 1 cm in length.

MINDANAO, Surigao Province, *Bur. Sci. 34439 Ramos & Pascasio,* April 25, 1919, along small streams at low altitudes.

A species belonging in the group with *Morinda umbellata* Linn., but distinguished from all forms of this species known to me by its vegetative characters.

### MORINDA NITIDA sp. nov.

Frutex scandens, glaber, ramulis 3 ad 5 mm diametro; foliis coriaceis, ellipticis, supra nitidissimis, 7 ad 11 cm longis, basi acutis, apice breviter obtuse acuminatis, nervis utrinque circiter 10, tenuibus; fructibus junioribus carnosis, globosis, circiter 2 cm diametro, laevis.

A glabrous, woody vine, the branchlets 3 to 5 mm in diameter, smooth, nearly black when dry. Leaves coriaceous, elliptic, the upper surface dark olivaceous to nearly black when dry, very conspicuously shining, the lower surface slightly shining and very dark brown, 7 to 11 cm long, 4.5 to 5.5 cm wide, the base acute or somewhat decurrent, the apex very shortly and obtusely acuminate; lateral nerves about 10 on each side of the midrib, slender, anastomosing, the primary reticulations lax; petioles 2 to 2.5 cm long; stipules ovate to ovate-lanceolate, acuminate, about 8 mm long. Fruits umbellately arranged at the tips of the branchlets, usually about 4 to each branchlet, globose, fleshy, about 2 cm in diameter, black when dry, their pedicels 2 to 2.5 cm long, the pericarp nearly smooth, the seeds apparently few.

BUCAS GRANDE, *Bur. Sci. 35074 Ramos & Pascasio,* June 11, 1919, in dry forests.

A species in some respects suggestive of *Morinda volubilis* Merr., but with entirely different infructescences. It is strongly characterized by its very shiny leaves, the upper surfaces of which appear as if they were varnished.

### MUSSAENDA Linnaeus

**MUSSAENDA ACUMINATISSIMA** sp. nov.

Frutex erectus, perspicue villosis; foliis in paribus subaequalibus, chartaceis, ovatis, usque ad 16 cm longis, basi decurrento-acuminatis, apice tenuiter subcaudato-acuminatis utrinque plus minusve villosis, nervis utrinque 10 ad 12 subtus perspicuis; cymis pedunculatis, circiter 8 cm diametro, bracteis lineari-lanceolatis, acuminatis, circiter 7 mm longis; floribus 3.5 ad 4 cm longis, sepalis lineari-lanceolatis, acuminatis, persistentibus, 1 ad 1.5 cm longis, sepala foliacea longe stipitata, limbo ovato ad elliptico-ovato, 4 ad 6 cm longo.

An erect shrub, 3 m high (*fide* Ramos), most parts prominently villous. Branches dark reddish-brown, lenticellate, glabrous, the branchlets densely ferruginous-villous. Leaves of each pair subequal, ovate, chartaceous, olivaceous when dry, 9 to 16 cm long, 5 to 8.5 cm wide, base rather abruptly contracted and long decurrent-acuminate, apex slenderly subcaudate-acuminate, the upper surface villous with scattered hairs, the lower surface densely villous with longer hairs on the midrib and nerves, the hairs on the reticulations more scattered; lateral nerves 10 to 12 on each side of the midrib, prominent on the lower surface; petioles 1.5 to 2 cm long, villous; stipules oblong, acute or acuminate, about 1.5 cm long. Cymes rather many-flowered, about 8 cm wide, villous, the indumentum castaneous to ferruginous, dense on the younger parts, the peduncles about 2.5 cm long;

bracts linear-lanceolate, acuminate, about 7 mm long. Flowers yellow, 3.5 to 4 cm long. Calyx-tube very densely villous, the lobes linear-lanceolate, persistent, villous, acuminate, 1 to 1.5 cm long, less than 2 mm wide. Corolla ferruginous-villous, somewhat expanded upward, the lobes ovate, somewhat acuminate, 5 to 6 mm long; foliaceous sepals long-stipitate, membranaceous, white, somewhat pubescent, the limb ovate to elliptic-ovate, 4 to 6 cm long, acuminate, the nerves and reticulations distinct. Fruit (immature) somewhat obovoid, sparingly pubescent, 1.5 cm long.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33133 Ramos,* August 8, 1918, on dry slopes, altitude about 700 meters.

Among those species with slender, elongated, persistent sepals this species is apparently most closely allied to *Mussaenda philippinensis* Merr., but differs radically from that in its indumentum and in its differently shaped, smaller, more-numerously nerved leaves.

### OPHIORRHIZA Linnaeus

**OPHIORRHIZA MACGREGORII** sp. nov.

Herba erecta, simplex vel parce ramosa, 5 ad 10 cm alta, ramis et foliis subtus et inflorescentiis dense puberulis; foliis ovatis ad ovato-ellipticis, usque ad 6 cm longis, membranaceis ad chartaceis, obtusis vel acutis, basi obtusis ad rotundatis, nervis utrinque 6 vel 7, tenuibus, distinctis; cymis breviter pedunculatis, densis, paucifloris, circiter 1 cm diametro; floribus circiter 5 mm longis, calycibus puberulis, corolla glabra; capsulis circiter 7.5 mm latis, truncatis vel subtruncatis, obscure puberulis.

An erect, simple or sparingly branched herb, 5 to 10 cm high, the stems, branches, and petioles rather densely subferruginous-puberulent, the indumentum usually pale on the midrib and nerves. Leaves ovate to ovate-elliptic, 2.5 to 6 cm long, 1.5 to 3 cm wide, membranaceous to chartaceous, obtuse or acute, base rounded to obtuse, entire, the upper surface cinereous to olivaceous, very minutely and obscurely subpapillate-puberulent, the lower surface pale, densely puberulent on the midrib and lateral nerves; nerves 6 or 7 on each side of the midrib, slender, distinct; petioles about 5 mm long. Cymes about 1 cm in diameter or less, rather dense, puberulent, rather few-flowered, their peduncles less than 1 cm long. Flowers white, about 5 mm long. Calyx subglobose, 1.3 mm long, the teeth 5, oblong, 0.2 mm long. Corolla-tube glabrous, 3 mm long, the lobes oblong, obtuse, 1 mm long. Capsule compressed, 7 to 8 mm wide, about 3 mm long, somewhat puberulent, the lobes spreading, rounded or obtuse, the apex of the capsule truncate or nearly so.

LUZON, Laguna Province, Paete, *Bur. Sci. 22944, 23024* (type) *McGregor,* June, 1915, in forests, altitude 100 to 200 meters.

This species is perhaps as closely allied to *Ophiorrhiza ovata* Merr. as any other species, but has differently shaped, somewhat larger leaves, dense inflorescences, and larger capsules which are truncate at their apices.

### OPHIORRHIZA OVATA sp. nov.

Herba erecta, simplex vel parce ramosa, usque ad 14 cm alta; foliis in paribus plus minusve inaequalibus, subtus ad costa nervisque parce puberulis, ovatis ad oblongo-ovatis, membranaceis, usque ad 5 cm longis, supra olivaceis, nitidis, subtus pallidis, apice acutis vel acuminatis, basi decurrento-acuminatis, nervis utrinque circiter 6, tenuibus; inflorescentiis laxis, tenuiter pedunculatis, usque ad 2.5 cm diametro, paucifloris; floribus glabris, corollae tubo circiter 2.5 mm longo.

An erect, simple or sparingly branched, nearly glabrous herb, up to 14 cm in height. Stems slender, somewhat pubescent. Leaves of each pair somewhat unequal in size, ovate to oblong-ovate, membranaceous, entire, 2 to 5 cm long, 1.5 to 2.3 cm wide, the upper surface olivaceous, shining, glabrous or with very few, widely scattered, short hairs, the lower surface pale, distinctly puberulent on the midrib and lateral nerves, the apex acute to acuminate, base decurrent-acuminate; lateral nerves about 6 on each side of the midrib, slender, distinct, anastomosing; petioles slender, 5 to 10 mm long, pubescent. Cymes lax, glabrous, few-flowered, their peduncles slender, about 1 cm long, the pedicels up to 4 mm in length. Flowers white, glabrous. Calyx ovoid, 1.2 to 1.5 mm long, the teeth 5, oblong, obtuse, 0.3 mm long. Corolla-tube cylindric, glabrous, 2.5 mm long, the lobes ovate, about 1 mm long. Capsule compressed, about 5 mm wide, the lobes divaricately spreading.

LUZON, Laguna Province, Siniloan-Infanta trail, near Fami, *Bur. Sci. 23163 McGregor,* July 20, 1915, on damp rocky stream banks.

This species is well characterized by its low stature, its usually ovate leaves, and its slender, peduncled, lax, glabrous inflorescences.

### OPHIORRHIZA PUBIFLORA sp. nov.

Herba erecta, simplex vel parce ramosa, 5 ad 12 cm alta, perspicue pubescens vel puberula; foliis in paribus distincte inaequalibus, oblongis ad oblongo-ovatis, usque ad 8 cm longis, in siccitate saepe nigrescentibus, acutis, basi obtusis ad subacutis, nervis utrinque 10 ad 14, distinctis; stipulis bifidis, lobis filiformibus, pubescentibus, 4 ad 6 mm longis; cymis pedunculatis, sub anthesis circiter 1.5 cm diametro, perspicue pubescentibus; floribus circiter 6.5 mm longis, corollae tubo dense pubescente; capsulis compressis, subflabelliformibus, circiter 4 mm longis et 7 mm latis, pubescentibus, apice rotundatis vel subtruncatis.

An erect, simple or sparingly branched herb, 5 to 12 cm high, most parts distinctly pubescent or puberulent, the stems mostly 3 to 6 cm long, somewhat woody below. Leaves of each pair distinctly unequal in size, in general oblong to oblong-ovate, 3 to 8 cm long, 1.5 to 3.5 cm wide, often black when dry, apex acute, base acute to rounded or obtuse, both surfaces more or less pubescent or puberulent, especially on the midrib and nerves; lateral nerves 10 to 14 on each side of the midrib, distinct, curved, anastomosing; stipules cleft into two filiform, pubescent, 4 to 6 mm long lobes; petioles 5 to 12 mm long, pubescent. Cymes peduncled, rather dense, about 1.5 cm in diameter in anthesis, all parts including the corolla densely pubescent. Flowers white, about 6.5 mm long, the pedicels short. Calyx ovoid, pubescent, 2 mm long, the teeth 5, 0.5 mm long. Corolla-tube densely pubescent, 3.5 mm long, the lobes oblong, obtuse, about 2 mm long. Capsules pubescent, compressed, about 7 mm wide and 4 mm long, subflabelliform, apex rounded to subtruncate, not lobed.

LUZON, Rizal Province, Mount Susong Dalaga, *Bur. Sci. 29353* (type), *29355 Ramos & Edaño,* in forests near the summit, altitude at least 1,000 meters.

This species somewhat resembles *Ophiorrhiza macgregorii* Merr., but is not closely allied to it. It is strongly characterized by its pubescent flowers and its pubescent, somewhat fan-shaped capsules which are compressed but not at all lobed, and rounded or truncate at their apices.

### OPHIORRHIZA STENOPHYLLA sp. nov.

Herba erecta, simplex, 7 ad 13 cm alta, caulibus dense cinereo-vel griseo-pubescentibus; foliis lanceolatis ad anguste lanceolatis, chartaceis, in paribus distincte inaequalibus, supra olivaceis, glabris vel subglabris, subtus pallidioribus, ad costa nervisque minutissime puberulis, 3 ad 7 cm longis, 0.5 ad 1.3 cm latis, utrinque angustatis, acuminatis, nervis utrinque circiter 10, tenuibus; inflorescentiis cymosis, paucifloris, tenuiter pedunculatis; floribus circiter 5 mm longis, corollae tubo glabro.

An erect, simple, slender herb, 7 to 13 cm high, the leaf-bearing part of the stem 3 to 5 cm in length, terete, densely cinereous- or griseous-pubescent. Leaves opposite, those of each pair distinctly unequal, lanceolate to narrowly lanceolate, 3 to 7 cm long, 5 to 13 mm wide, chartaceous, entire, subequally narrowed to the somewhat acuminate or merely acute base and apex, the upper surface olivaceous, slightly shining, glabrous, or with very few, widely scattered, very short hairs, the lower surface paler, densely and minutely puberulent on the midrib and nerves; lateral nerves about 10 on each side of the midrib, slender; petioles 2 to 5 mm long; stipules triangular-ovate, about 2 mm long, acute. Cymes few-flowered, 1 to 1.5 cm in diameter, their slender peduncles densely pubescent, 1.5 to 3 cm long, the branches and pedicels pubescent, ebracteate. Flowers about 5 mm long. Calyx slightly urceolate, externally minutely pubescent, about 1.8 mm long, the teeth 5, oblong-ovate, acute, 0.3 mm long. Corolla-tube cylindric, 3 mm long, glabrous, the lobes oblong, obtuse, 1.5 mm long. Fruits compressed, 2 mm long, 5 mm wide, glabrous, crowned with the 5 minute calyx-teeth.

LUZON, Cavite Province, Alfonso, *Bur. Sci. 22591 Ramos & Deroy,* May 11, 1915, on rocks along small streams, altitude about 600 meters.

This species is well characterized by its narrow, entire leaves, its densely pubescent simple stems, and its slenderly peduncled inflorescences.

**OPHIORRHIZA TENUIS** sp. nov.

Herba tenuis, prostrata vel adscendens, plus minusve pubescentibus, simplex vel distanter ramosis, usque ad 20 cm longis; foliis parvis, aequalibus, membranaceis, ellipticis ad oblongo-ellipticis, circiter 1 cm longis, utrinque acutis vel subobtusis, nervis útrinque circiter 4; cymis tenuiter pedunculatis paucifloris, haud 1 cm diametro; floribus circiter 3 mm longis, glabris; capsulis compressis, circiter 5 mm latis et 2.5 mm longis, apice subtruncatis, glabris, obscure bilobatis, lobis rotundatis.

A slender, prostrate or ascending, simple or distantly branched herb, copiously rooting at the lower nodes, up to 20 cm in length, the stems distinctly pubescent. Leaves in equal pairs, small, membranaceous, elliptic to oblong-elliptic, 8 to 13 mm long, 5 to 8 mm wide, the upper surface olivaceous, glabrous, shining, the lower pale, puberulent on the midrib and nerves, subequally narrowed to the acute to somewhat obtuse base and apex; lateral nerves about 4 on each side of the midrib, slender, distinct;

petioles pubescent, 2 to 3 mm long; stipules linear, entire, about 1 mm long. Cymes rather dense, few-flowered, slenderly peduncled, less than 1 cm in diameter, their peduncles pubescent, about 1.5 cm long. Flowers (young) about 3 mm long. Calyx globose, about 1 mm long, glabrous, the teeth oblong, 0.5 mm long, the pedicels 1 mm long or less. Capsules glabrous, compressed, about 5 mm wide and 2 to 2.5 mm long, apex nearly truncate, crowned with the 5 distinct calyx-teeth, the lateral lobes spreading, rounded.

LUZON, Rizal Province, Mount Lumutan, *Bur. Sci. 29785 Ramos & Edaño,* August 17, 1917, in forests near the summit, altitude apparently about 1,000 meters.

This species is strongly characterized by its slender, elongated, prostrate stems which root at the nodes and its small leaves. It is not at all closely allied to any previously described Philippine species.

### PLECTRONIA Linnaeus

#### PLECTRONIA BRUNNEA sp. nov.

Frutex erectus, subglaber, novellis minutissime puberulis; foliis in siccitate brunneis, oblongis, subcoriaceis, usque ad 19 cm longis, junioribus subtus parcissime castaneo-puberulis, perspicue acuminatis, basi leviter decurrento-acuminatis, nervis utrinque 7 ad 9, perspicuis, evanescentibus, reticulis obsoletis; fructibus axillaribus, solitariis vel binis, oblongo-obovoideis, compressis, in siccitate nigris, nitidis, rugosis, obtusis, basi attenuatis, circiter 1.5 cm longis.

An erect, subglabrous shrub, the very young parts and the lower surfaces of young leaves sparingly castaneous-puberulent, soon becoming glabrous. Branches terete, dark-brown or reddish-brown, the young branchlets more or less compressed and sulcate. Leaves uniformly dark-brown above and paler brown beneath when dry, oblong, subcoriaceous, 14 to 19 cm long, 5 to 7 cm wide, shining, the apex conspicuously acuminate, acumen slender, elongated, acute or subacute, sometimes falcate, base broad, somewhat decurrent-acuminate; lateral nerves 7 to 9 on each side of the midrib, prominent, curved, evanescent, the reticulations obsolete; petioles about 8 mm long; stipules lanceolate-acuminate from a somewhat ovate base, about 1 cm long. Fruits axillary, solitary or in pairs on a very short peduncle, subtended by a pair of ovate, caudate-acuminate bracts about 5 mm in length, the peduncle and pedicels about 3 mm long, the fruits, when dry, oblong-ovoid, rugose, compressed, shining, obtuse, base acute, about 1.5 cm long and 1 cm wide.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28791* (type), *28612 Ramos & Edaño,* May, 1917, in the mossy forest, apparently at an altitude of about 1,000 meters.

This species is well characterized by its rather large, oblong, brown leaves, the nerves being prominent but evanescent before reaching the margins and the reticulations being obsolete; and its axillary or solitary, compressed, oblong-ovate fruits which are about 1.5 cm long, compressed and rugose when dry.

**PLECTRONIA OLIGOPHLEBIA** sp. nov.

Frutex glaber; foliis crassissime coriaceis, oblongis, usque ad 5 cm longis, in siccitate brunneis vel atro-brunneis, brevissime petiolatis, utrinque acutis, subtus in axillis haud glandulosis, nervis utrinque 2 vel 3, subtus prominulis, adscendentibus, distinctis, reticulis obsoletis; inflorescentiis axillaribus, solitariis, umbellatis, umbellis 7- ad 12-floris, brevissime pedunculatis vel superioribus sessilibus; floribus parvis, circiter 4.5 mm diametro.

A glabrous shrub, 4 mm high (*fide* Ramos), the branches somewhat thickened, the branchlets somewhat 4-angled, the internodes 1 cm long or less. Leaves oblong, very thickly coriaceous, brown or blackish-brown when dry, slightly shining, smooth, 3.5 to 5 cm long, 1.2 to 1.6 cm wide, subequally narrowed to the acute base and apex; lateral nerves 2 or 3 on each side of the midrib, ascending, distinct, slightly raised on the lower surface; stipules broad, 1.5 to 2 mm long; petioles 1 mm long or less. Umbels axillary, solitary, 7- to 12-flowered, the peduncles 2 mm long or less, the upper inflorescences often sessile; pedicels 4 to 5 mm long. Flowers green, about 4.5 mm in diameter, the calyx about 2 mm in diameter, shortly 4-toothed. Corolla-tube about 1 mm long, the lobes broadly ovate, acute, spreading, about 2 mm long.

LUZON, Rizal Province, Mount Susong Dalaga, *Bur. Sci. 29342 Ramos & Edaño,* August 7, 1917, in the mossy forest at the summit, apparently at or above an altitude of 900 meters.

The alliance of this species is manifestly with *Plectronia gynochthodes* Baill. (*P. umbellata* K. Schum.), from which it is distinguished by its smaller, fewer-nerved leaves and its very shortly peduncled to sessile umbels. It is less closely allied to *Plectronia ramosii* Merr., the latter species differing in its longer petioles, peduncles, and pedicels, and in numerous other characters.

**PLECTRONIA RAMOSII** sp. nov.

Species *P. gynochthodes* Baill. affinis, differt foliis minoribus, umbellulis 2- ad 4-floris. Arbor parva, glabra, ramis tenuibus, brunneis; foliis subcoriaceis, oblongis, utrinque subaequaliter attenuatis et acuminatis, usque ad 5 cm longis, in siccitate supra castaneis vel olivaceo-brunneis, nitidis, subtus in axillis barbato-glandulosis, nervis utrinque 3 vel 4, tenuibus, reticulis obsoletis; umbellulis axillaribus, solitariis, pedunculatis, 2- ad 4-floris; fructibus obovoideis, brunneis, nitidis, in siccitate rugosis, circiter 1 cm longis.

A small, glabrous tree, about 8 m high, the branches and branchlets terete, the former pale-brownish or grayish, the latter slender, reddish-brown. Leaves in general oblong, equally attenuate and acuminate at both ends, 4 to 5 cm long, 1 to 2 cm wide, subcoriaceous, the upper surface castaneous to olivaceous brown when dry, smooth, shining, the lower surface paler, glandular and bearded in the axils; lateral nerves slender, not prominent, 3 or 4 on each side of the midrib, the reticulations obsolete; petioles 1 cm long or less. Umbels axillary, solitary, 2- to 4-flowered, their peduncles slender, about 8 mm long, the pedicels about as long as the peduncles. Fruits brown, shining, and somewhat rugose when dry, obovoid, about 1 cm long, 2- or 1-seeded.

LUZON, Tayabas Province, Umiray, *Bur. Sci. 28973 Ramos & Edaño,* June 1, 1917, in forests along the Umiray River at low altitudes.

The alliance of this species is manifestly with *Plectronia gynochthodes* Baill. [*P. umbellata* (Bartl.) K. Schum.], from which it is distinguished by its smaller, fewer-nerved leaves and few-flowered umbels.

**PLECTRONIA SUBCAPITATA** sp. nov.

Arbor glabra, circiter 8 m alta, ramis teretibus, ramulis compressis, sulcatis, brunneis, internodiis elongatis; foliis oblongis ad oblongo-lanceolatis, chartaceis ad subcoriaceis, usque ad 25 cm longis, in siccitate brunneis, nitidis, sursum attenuatis et perspicue acuminatis, basi acutis ad decurrento-acuminatis, nervis primariis utrinque circiter 5, curvato-adscendentibus, perspicuis, reticulis obsoletis; inflorescentiis axillaribus, solitariis, pedunculatis, subcapitatis, bracteis binis abrupte longecuspidatis subtensis, pedunculis patulis vel recurvatis, 1 ad 1.5 cm longis; floribus numerosis, umbellatim dispositis, 4-meris, circiter 6 mm longis.

A glabrous tree, about 8 m high, the branches and branchlets smooth, brown, the latter compressed and sulcate, the internodes up to 8 cm in length. Leaves oblong to oblong-lanceolate, brown and shining when dry, chartaceous to subcoriaceous, 15 to 25 cm long, 4.5 to 6 cm wide, narrowed upward to the prominently long-acuminate apex, the base acute to somewhat decurrent-acuminate; lateral nerves about 5 on each side of the midrib, prominent, curved-ascending, evanescent, the reticulations obsolete; petioles 1.5 to 2 cm long; stipules broadly triangular, acuminate, about 5 mm long. Inflorescences axillary, solitary, peduncled, the peduncles 1 to 1.5 cm long, spreading or recurved, bearing at their tips a pair of prominent bracts, the basal portions of the bracts broadly ovate, about 5 mm in diameter, abruptly cuspidate-acuminate, the projecting tip about 5 mm long. Flowers subtended by the bracts, umbellately arranged, up to 25 in each inflorescence, greenish-white, their pedicels about 6 mm long. Buds cylindric, 6 mm long. Calyx-teeth lanceolate, acuminate, 1.3 mm long. Corolla-tube 4 mm long, bearded within, the lobes 4, oblong-lanceolate, acute or slightly acuminate, about 2 mm long. Stigma capitate. Anthers 1.4 mm long, ellipsoid.

LUZON, Apayao Subprovince, Ngagan, *Bur. Sci. 28117 Fénix*, May 10, 1917, on forested slopes, locally known as *apaypay*.

A species well characterized by its axillary, solitary, conspicuously bracteate, peduncled, subcapitate inflorescences.

### PSYCHOTRIA Linnaeus

**PSYCHOTRIA AMPLISSIMA** sp. nov.

Frutex circiter 1 m altus, glaber; foliis magnis, usque ad 30 cm longis et 14 cm latis, ellipticis ad late oblongo-obovatis, subcoriaceis, nitidis, apice obtusis ad rotundatis, basi angustatis, cuneatis, nervis utrinque circiter 24, subtus valde prominentibus; stipulis lanceolatis, acuminatis, subcoriaceis, 3 ad 3.5 cm longis; cymis terminalibus, e basi ramosis, floribus circiter 5 mm longis, in ramis ultimis plus minusve confertis.

A shrub, about 1 m high, quite glabrous, the branches apparently terete. Leaves elliptic to broadly oblong-obovate, about 30 cm long and 14 cm wide, somewhat pale and shining when dry, subcoriaceous, the apex obtuse to broadly rounded, base narrowed, cuneate or decurrent-acuminate; lateral nerves about 24 on each side of the midrib, very prominent on the lower surface, spreading-curved, anastomosing close to the margin, the primary reticulations rather lax, distinct; petioles 5 to 7 cm long; stipules subcoriaceous, lanceolate, acuminate, brownish when dry, 3 to 3.5 cm long. Inflorescence a terminal cyme about 11 cm long, with two primary branches from the base, the main rachis and primary branches again branched at or above the upper one-third, the flowers rather crowded on the ultimate branchlets, their pedicels up to 5 mm in length. Calyx rather shallow, acutely toothed. Corolla, in bud, about 4.5 mm long, the throat villous inside.

LEYTE, Dagami, *Bur. Sci. 15198 Ramos,* August 9, 1912, along streams in forests.

Among all the Philippine species *Psychotria amplissima* is readily distinguished by its very large, obtuse or rounded, prominently nerved, long-petioled leaves and its long stipules.

**PSYCHOTRIA CAPIZENSIS** sp. nov.

Frutex erectus, ramulis et inflorescentiis et subtus foliis ad costa nervisque plus minusve castaneo-pubescens; foliis subcoriaceis, oblongo-ellipticis, 8 ad 12 cm longis, utrinque subaequaliter angustatis, basi acutis, apice leviter acuminatis, nervis utrinque circiter 20, subtus valde perspicuis; infructescentiis circiter 2 cm longis, fructibus paucis, obovoideis, 5 mm longis, haud sulcatis, albumine aequabile.

An erect shrub, the branchlets, petioles, midrib, and nerves on the lower surface, and the inflorescences more or less castaneous-pubescent, branches terete, glabrous. Leaves subcoriaceous, oblong-elliptic, brownish when dry, 8 to 12 cm long, 3 to 5 cm wide, subequally narrowed to the acute base and slightly acuminate apex, the short acumen usually blunt; lateral nerves about 20 on each side of the midrib, very prominent on the lower surface, parallel, slightly curved, arched-anastomosing near the margin, the reticulations rather close, distinct; petioles 1 to 2 cm long, in age glabrous; stipules deciduous. Infructescences terminal, simple, about 2 cm long, densely pubescent. Fruits few, obovoid, yellow when fresh, black when dry, glabrous, about 5 mm long, not at all sulcate, base acute and apex broadly rounded; seeds plano-convex, the albumen not at all ruminate.

PANAY, Capiz Province, Mount Madiaas, *Bur. Sci. 30657 Ramos & Edaño,* May 13, 1918, in forests, altitude not indicated.

This species somewhat resembles the ones associated with *Psychotria bataanensis* Elm., most of which belong in the section *Grumilea.* Among these it most closely resembles *Psychotria rizalensis* Merr., from which it differs not only in its longer pedicels and non-sulcate fruits, but also in its albumen not being at all ruminate.

**PSYCHOTRIA CASTANEA** sp nov. § *Grumilea.*

Frutex erectus, glaber, ramulis tenuibus, brunneis vel rubro-brunneis; foliis anguste lanceolatis, chartaceis, usque ad 10 cm longis, in siccitate utrinque castaneis, utrinque subaequaliter angustatis et acuminatis, nervis utrinque circiter 13, tenuibus, reticulis obscuris vel subobsoletis; fructibus fasciculatis, sessilibus vel breviter pedicellatis, castaneis, ellipsoideis, laevis, circiter 7.5 mm longis, haud sulcatis; seminibus plano-convexis, albumine ruminato.

An erect, glabrous shrub, the branchlets brown or reddish-brown, terete, smooth. Leaves chartaceous, castaneous and slightly shining when dry, both surfaces of the same color, 6 to 10 cm long, 1 to 2 cm wide, narrowly lanceolate, subequally narrowed to the acuminate base and apex; lateral nerves about 13 on each side of the midrib, slender, the reticulations lax, obscure, sometimes nearly obsolete; petioles slender, 1 to 1.5 cm long; stipules sheathing, about 5 mm long. Fruits terminal, ellipsoid, fascicled, sessile or shortly pedicelled, castaneous when dry, smooth, not at all sulcate, about 7.5 mm long, the pericarp rather brittle; seeds plano-convex, not sulcate; albumen ruminate.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33212 Ramos* (type), August 8, 1918, on dry slopes, altitude about 700 meters, fruits sessile; between Bangui and Claveria, *Bur. Sci. 33061 Ramos,* August 30, 1918, fruits shortly pedicelled.

The striking character of this species consists in the sessile or shortly pedicelled fruits which are borne in terminal fascicles of from two to five fruits each; these fascicles sometimes become lateral by the growth of young shoots after anthesis. It is otherwise strongly characterized by its castaneous, narrowly lanceolate leaves. Its alliance is with *Psychotria* (*Grumilea*) *fasciculiflora* Merr., from which it is readily distinguished by its much smaller, fewer-nerved leaves.

**PSYCHOTRIA CARDIOPHYLLA** sp. nov. § *Grumilea.*

Frutex erectus, plus minusve castaneo-pubescens; foliis oblongo-ellipticis ad obovatis, usque ad 18 cm longis, subcoriaceis, obtuse acuminatis, basi perspicue cordatis, in siccitate pallidis vel subtus brunneis, nervis utrinque circiter 16, valde perspicuis, curvatis, anastomosantibus, petiolis castaneo-pubescens, 1.5 ad 3 cm longis; inflorescentiis terminalibus, e basi 3-ramosis, ramis 3 cm longis, fructibus junioribus obovoideis, circiter 8 mm longis, laevis, haud sulcatis, subcapitato dispositis.

An erect shrub, the branchlets, petioles, inflorescences, and the lower surface of the leaves on the midribs and nerves castaneous-pubescent with short, rather harsh hairs. Branches terete, wrinkled, glabrous, grayish or brownish, about 4 mm in diameter. Leaves subcoriaceous, oblong-elliptic to oblong-obovate, 15 to 18 cm long, 6 to 9.5 cm wide, the upper surface pale, shining, the lower brownish or reddish-brown, the apex blunt-acuminate, base somewhat narrowed (3 to 4 cm) and abruptly and conspicuously cordate, the sinus narrow, the lobes rounded; lateral nerves about 16 on each side of the midrib, very prominent on the lower surface, somewhat curved, distinctly anastomosing, the primary reticulations distinct; petioles densely castaneous-pubescent, 1.5 to 3 cm long; stipules deciduous, not seen. Inflorescences terminal, castaneous-pubescent, 3-branched from the base, the branches about 3 cm long, each bearing at its apex a subcapitate infructescence 2 to 2.5 cm in diameter. Fruits 10 to 15 on each branch, the immature ones obovoid, about 8 mm long, smooth, not at all sulcate, dark-brown when dry, glabrous, their pedicels 3 to 5 mm long, pubescent.

LUZON, Tayabas Province, Infanta-Siniloan trail, *Bur. Sci. 29166 Ramos & Edaño,* June 12, 1917, along small streams in forests.

The alliance of this species is manifestly with *Psychotria alvarezii* Merr., from which it differs in its broader, differently shaped leaves and, especially, in its fruits, which are not at all longitudinally sulcate.

**PSYCHOTRIA CORDATULA** sp. nov. § *Grumilea.*

Frutex erectus, plus minusve castaneo-pubescens; foliis subcoriaceis, oblongo-lanceolatis, 15 ad 20 cm longis, acutis, basi abrupte et perspicue auriculato-cordatis, nervis utrinque circiter 20, perspicuis, patulis; petiolo 3 ad 4 cm longo; infructescentiis 3 ad 5 cm longis, simplex, fructibus glomeratim confertis, pedicellatis, subglobosis ad obovoideis, laevis, 5 ad 6 mm longis, pyrenis plano-convexis, haud carinatis, albumine ruminato.

An erect shrub, the branchlets, inflorescences, petioles, and the leaves on the lower surface more or less castaneous-pubescent with short hairs. Branches terete, glabrous, reddish-brown. Leaves subcoriaceous, oblong-lanceolate, 15 to 20 cm long, 4.5 to 6.5 cm wide, the apex acute or very obscurely acuminate, the base abruptly rounded and conspicuously auriculate-cordate 2.5 to 3 cm across the base, the sinus narrow, up to 8 mm deep, the upper surface glabrous, smooth; lateral nerves about 20 on each side of the midrib, prominent, spreading, anastomosing; petioles 3 to 4 cm long. Infructescences terminal, usually 2 terminating each branchlet, 3 to 5 cm in length, unbranched, the fruits glomerately crowded at the apices of the peduncles, their pedicels 2 to 3 mm in length. Fruit black when dry, somewhat fleshy, subglobose to obovoid, smooth, 5 to 6 mm long, the pyrenes plano-convex, not at all ridged, the albumen ruminate.

LUZON, Bontoc Subprovince, Mount Masapilid, *Bur. Sci. 37854 Ramos & Edaño*, March 15, 1920, in the mossy forests, altitude about 1,250 meters.

This species is very strongly characterized by its relatively long petioles, its conspicuously auriculate-cordate leaf bases, and by its fruits being glomerately crowded at the apices of the peduncles. It is allied to *Phsychotria cardiophylla* Merr. but has very differently shaped, more-numerously nerved leaves.

**PSYCHOTRIA ELLIPTILIMBA** sp. nov. § *Grumilea.*

Frutex erectus, glaber; foliis chartaceis, ellipticis ad oblongo-ellipticis, usque ad 10 cm longis, supra olivaceis, subtus pallidioribus, nitidis, apice rotundatis vel brevissime apiculatis, basi obtusis, nervis utrinque circiter 9, perspicuis; infructescentiis pedunculatis, trichotomis, fructibus sessilibus in apicem ramis primariis fasciculatis dispositis, oblongo-obovoideis, circiter 1 cm longis, in siccitate castaneis, leviter rugosis, haud sulcatis; pyrenis plano-convexis, albumine valde ruminato.

An erect, glabrous shrub, about 1 m high (*fide* Ramos). Leaves chartaceous, elliptic to oblong-elliptic, 6 to 10 cm long, 3 to 4.5 cm wide, the upper surface olivaceous, the lower paler, shining, apex rounded or minutely apiculate, base usually obtuse; primary lateral nerves about 9 on each side of the midrib, prominent, brownish to reddish-brown on the lower surface when dry, curved, scarcely anastomosing, the reticulations obsolete or nearly so; petioles 1.3 to 2 cm long; stipules deciduous, the stipular scar on the very young branchlets more or less pubescent. Inflorescences terminal, solitary, peduncled, trichotomous, 5 to 7 cm long, the peduncles 1.5 to 3 cm long, the primary branches 3 to 4 cm in length, each bearing at its tip a fascicle of three to six, sessile, oblong-obovoid fruits. Fruits red when fresh, castaneous when dry, about 1 cm long, somewhat rugose but not at all sulcate. Pyrenes plano-convex, not at all ridged or sulcate. Albumen prominently ruminate.

CATANDUANES, Santo Domingo River, *Bur. Sci. 30534 Ramos*, December 5, 1917, on forested slopes at low altitudes.

This species is well characterized by its vegetative and inflorescent characters. In the texture and color of its leaves it somewhat resembles *Psychotria subsessiliflora* Elm., but is not closely allied to that species, differing radically in leaf form and in its inflorescent characters.

**PSYCHOTRIA FENICIS** sp. nov.

Frutex erectus, glaber, 1 ad 2 m altus; foliis coriaceis, oblongo-ellipticis ad elliptico-ovatis, usque ad 15 cm longis, utrinque subaequaliter angustatis, basi acutis, apice breviter acuminatis; nervis lateralibus utrinque circiter 15, perspicuis, patulis, leviter curvatis, distincte anastomosantibus, reticulis distinctis; infructescentiis terminalibus, solitariis, brevibus, 2 ad 2.5 cm longis, e basi ramosis; fructibus paucis, obovoideis, circiter 9 mm longis, breviter pedicellatis, in siccitate rugosis; pyrenis plano-convexis, leviter sulcatis, seminibus obscure bicarinatis, albumine aequabile.

An erect, glabrous shrub, 1 to 2 m high. Leaves coriaceous, oblong-elliptic to elliptic-ovate, 11 to 15 cm long, 5 to 7 cm wide, subequally narrowed to the acute base and the rather shortly acuminate apex, somewhat shining, somewhat reddish-brown when dry, of about the same color on both surfaces, beneath usually pustulate; lateral nerves about 15 on each side of the midrib, spreading, slightly curved, distinctly anastomosing, prominent on both surfaces, the reticulations distinct; petioles 1 to 2 cm long. Panicles short, simple or branched from the base, 2.5 cm long or less, the basal branches 13 mm long or less. Fruits obovoid, about 9 mm long, greenish-yellow when fresh, when dry brown, rugose, their pedicels about 2 mm long. Pyrenes shallowly ridged. Seeds obscurely bicarinate, the albumen uniform.

LUZON, Pangasinan Province, Mount San Isidro, Labrador, *Bur. Sci. 28814* (type), *29967 Fénix,* November 4 and 9, 1917, on forested slopes and ridges, altitude 200 to 400 meters.

The species is well characterized by its short inflorescences, and rather thickly coriaceous, usually pustulate leaves. It is perhaps as closely allied to *Psychotria gitingensis* Elm. as any other species but is remote from it in vegetative, inflorescent, and fruit characters.

**PSYCHOTRIA HETEROMERA** sp. nov. § *Grumilea.*

Frutex erectus, perspicue ferrugineo- ad castaneo-ciliatus; foliis chartaceis ad subcoriaceis, oblongo-ellipticis ad oblongo-obovatis, usque ad 10 cm longis, utrinque subaequaliter angustatis, apice acuminatis, basi acutis, nervis utrinque 9 ad 11; inflorescentiis plerumque e basi 3-ramosis, ramis 2 ad 3 cm longis, floribus omnibus sessilibus, subcapitato dispositis, 5- ad 7-meris, calycis circiter 8 mm longis, dentibus 2 ad 3 mm longis.

An erect shrub, the branchlets, petioles, leaves on both surfaces but especially beneath, and inflorescences prominently ciliate with ferruginous to castaneous, rather weak, spreading hairs. Branches terete, grayish to brownish, the internodes 4 to 7 mm long. Leaves chartaceous to subcoriaceous, dark-brown to brownish-olivaceous when dry, oblong-elliptic to oblong-obovate, 5 to 10 cm long, 2 to 4 cm wide, subequally narrowed to the acute base and to the sharply acuminate apex, somewhat shining, both surfaces with scattered, rather weak, spreading hairs, the upper surface often becoming glabrous, the midrib and nerves on the lower surface prominently ciliate; lateral nerves 9 to 11 on each side of the midrib, prominent, curved, anastomosing, the reticulations obsolete or nearly so; petioles 1 to 1.5 cm long, prominently ciliate; stipules membranaceous, broadly ovate, acuminate, usually lobed, for the most part glabrous but with some hairs on the back and the margins. Inflorescences usually 3-branched from the base, the branches 2 to 3 cm long, conspicuously castaneous-ciliate, each bearing at its apex a subcapitate partial inflorescence, the flowers all sessile and subtended by a pair of broadly ovate, pubescent, 3 to 4 mm long bracts, and each flower by an obovate to lanceolate, obtuse to acuminate, 3 to 4 mm long, ciliate bracteole, the individual heads about 1.5 cm in diameter. Calyx ovoid, about 8 mm long and 4 mm wide, slightly ciliate, the tube elongated and produced 4 to 5 mm above the ovary, the teeth 5 to 7, 2 to 3 mm long, ovate-lanceolate, acuminate. Corolla-tube cylindric, about 7 mm long, glabrous, the lobes 5 to 7, oblong, obtuse, about 5 mm long. Stamens 5 to 7, their filaments 3 mm long. Throat bearded.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28773* (type), *28602 Ramos & Edaño,* May, 1917, in the mossy forest, altitude apparently about 1,000 meters.

This species is strongly characterized by its subcapitate partial inflorescences; its indumentum; its sessile, 5- to 7-merous flowers; and its relatively greatly produced calyx-tube. It somewhat resembles *Psychotria pilosella* Elm., but is not closely allied to that species.

**PSYCHOTRIA LANCILIMBA** sp. nov. § *Grumilea.*

Frutex glaber, scandens (?); foliis chartaceis, lanceolatis ad oblongo-lanceolatis, usque ad 12 cm longis, olivaceis, tenuiter acuminatis, basi acutis, nervis utrinque circiter 15, perspicuis, anastomosantibus, reticulis distinctis, densis; stipulis anguste oblongis, circiter 1 cm longis; infructescentiis simplicibus vel e basi ramosis, circiter 2 cm longis; fructibus obovoideis, sessilibus, in ramis primariis subcapitato-dispositis, circiter 8 mm longis, haud sulcatis; pyrenis plano-convexis, albumine ruminato.

A glabrous shrub, apparently scandent. Leaves chartaceous, lanceolate to oblong-lanceolate, olivaceous, shining, and of about the same color on both surfaces when dry, 8 to 12 cm long, 2 to 3 cm wide, narrowed upward to the slenderly acuminate apex and below to the cuneate base; primary nerves about 15 on each side of the midrib, prominent, curved, anastomosing, the reticulations distinct, the ultimate ones rather dense; petioles about 1 cm long; stipules narrowly oblong, deciduous, about 1 cm long. Infructescences terminal, solitary, about 2 cm long, simple or branched from the base, the branches never more than two. Fruits sessile, subcapitately arranged at the ends of the branches, obovoid, red when fresh, black when dry, smooth, about 8 mm long, not at all sulcate. Pyrenes plano-convex, not at all ridged; albumen ruminate.

LUZON, Rizal Province, Mount Lumutan, *Bur. Sci. 29713* (type), *29629 Ramos,* August 17 and 30, 1917, in the mossy forest, apparently at an altitude of about 1,000 meters.

In vegetative characters this species closely resembles *Psychotria pinnatinervia* Elm., but is totally different in its infructescence and in its fruit characters. The imperfect notes with the specimens would indicate that it is a small shrub, but the dried specimens have all the appearance of being from vines, while several of the branchlets bear rootlets at the nodes.

**PSYCHOTRIA LONGIPETIOLATA** sp. nov. § *Grumilea.*

Frutex vel arbor parva, glaberrima; foliis oblongis ad oblongo-ovatis, usque ad 25 cm longis, subolivaceis, nitidis, coriaceis vel subcoriaceis, superne angustatis, acutis, basi acutis vel leviter decurrento-acuminatis, nervis primariis utrinque 15 ad 20, perspicuis, anastomosantibus, reticulis distinctis; petiolo 4 ad 6 cm longo; paniculis pyramidatis, 8 ad 12 cm longis, ramis basalibus 2, patulis; fructibus numerosis, obovoideis, in siccitate brunneis ad atro-brunneis, leviter rugosis, longitudinaliter sulcatis, 5 ad 7 mm longis; pyrenis plano-convexis, dorso late 3-carinato, albumine ruminato.

A shrub or small tree, entirely glabrous. Branches rugose, pale-brownish, the branchlets usually smooth, brown. Leaves oblong to oblong-ovate, 20 to 25 cm long, 7 to 10 cm wide, subolivaceous, of about the same color and shining on both surfaces when dry, narrowed upward to the acute apex and below to the acute to somewhat decurrent-acuminate base; primary lateral nerves 15 to 20 on each side of the midrib, conspicuous on both surfaces as are the reticulations, somewhat curved, anastomosing; petioles 4 to 6 cm long. Panicles pyramidal, with two primary branches from the base, the infructescences 8 to 12 cm long, the lower branches 6 to 7 cm long. Fruits numerous, reddish-yellow when fresh, brown to blackish-brown when dry, obovoid, somewhat rugose, shallowly sulcate, 5 to 7 mm long, their pedicels 2 to 3 mm in length. Pyrenes plano-convex, the back with three broad, not very conspicuous ridges or keels. Albumen ruminate.

CATANDUANES, Santo Domingo River and Mount Mariguidon, *Bur. Sci. 30418* (type), *30567, 30416 Ramos,* November and December, 1917, on forested slopes.

This species, well characterized by its relatively large, long-petioled, thick leaves, is probably as closely allied to *Psychotria plumeriaefolia* Elm. as any other species.

**PSYCHOTRIA LUCIDA** sp. nov. § *Grumilea.*

Frutex vel arbor parva, glaberrima; foliis chartaceis, in siccitate rigidis, fragilis, olivaceis, utrinque concoloribus, nitidis, oblongo-lanceolatis ad oblongis, usque ad 17 cm longis, utrinque subaequaliter angustatis et acuminatis, nervis utrinque circiter 11, perspicuis, curvatis, anastomosantibus, reticulis laxissimis, obscuris; paniculis longe pedunculatis, usque ad 14 cm longis, ramis patulis, inferioribus usque ad 4 cm longis; fructibus subellipsoideis, in siccitate nigris, nitidis, rugosis, 7 ad 8 mm longis; pyrenis plano-convexis, albumine valde ruminato.

A shrub or small tree, entirely glabrous, the branches brownish or grayish, the branchlets brown, smooth. Leaves chartaceous, rigid and brittle when dry, oblong-lanceolate to oblong or even oblong-elliptic, 12 to 17 cm long, 3 to 6 cm wide, subequally narrowed to the acuminate apex and base, olivaceous, of the same color and shining on both surfaces when dry; lateral nerves about 11 on each side of the midrib, prominent, curved, anastomosing, the reticulations very lax, obscure; petioles 1.5

to 3 cm long; stipules ovate, acuminate, 5 to 7 mm long. Panicles terminal, solitary, including the peduncle 11 to 14 cm in length, the peduncles 7 to 8 cm long; branches spreading, the lower ones up to 4 cm in length. Fruits subellipsoid, yellowish when fresh, black and somewhat shining and slightly rugose when dry, 7 to 8 mm long, often with faint longitudinal lines but scarcely ridged or sulcate. Seeds plano-convex, the albumen very prominently ruminate.

LUZON, Rizal Province, Mount Lumutan, *Bur. Sci. 29716* (type), *29632 Ramos & Edaño,* August 23, 1917, in forests near the summit, apparently at an altitude of about 1,000 meters.

This species is in the group with *Psychotria malayana* Jack, and is probably as closely allied to *P. luconiensis* (Cham.) F.-Vill. as to any other species. It is readily distinguished by its larger leaves and long-peduncled panicles.

**PSYCHOTRIA MAGNIFOLIA** sp. nov.

Frutex 3 ad 4 m altus, glaber, vel inflorescentiis junioribus obscure pubescens; ramulis compressis, 1 ad 1.5 cm diametro; foliis obovatis ad oblanceolatis, usque ad 55 cm longis, brevissime et obtuse acuminatis, deorsum angustatis, basi acutis vel cuneatis, breviter petiolatis, nervis utrinque circiter 25; stipulis membranaceis, ovatis, ad oblongo-ovatis, 3 ad 5 cm longis; inflorescentiis e basi 3-ramosis, ramis elongatis, usque ad 20 cm longis, partibus floriferis 3 ad 6 cm longis, floribus fasciculato-confertis, pedicellatis, circiter 8 mm longis.

An erect, glabrous shrub, 3 to 4 m high, the branchlets stout, compressed, 1 to 1.5 cm in diameter, brownish. Leaves unusually large for the genus, obovate to oblanceolate, 45 to 55 cm long, 14 to 22 cm wide, subolivaceous and shining when dry, chartaceous, the apex broadly and shortly blunt-acuminate, below narrowed to the acute or cuneate base; lateral nerves about 25, prominent, curved, scarcely anastomosing, the reticulations lax, not prominent; petioles stout, 1.5 to 2.5 cm long; stipules membranaceous, nearly black when dry, ovate to oblong-ovate, acute, 3 to 5 cm long. Inflorescences 3-branched from the base, the central branch up to 20 cm in length, the lateral ones 10 to 15 cm long, flower-bearing only in the upper 3 to 6 cm, the flowers here fascicled, crowded, forming a subcylindric partial inflorescence, or interruptedly glomerate; pedicels about 6 mm long. Calyx turbinate, about 3 mm in diameter, the teeth 5, short. Corolla white, the tube 3 mm long, the lobes elliptic-ovate, acute, 5 mm long, the throat densely bearded.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28828* (type) *Ramos & Edaño,* May 11, 1917; Mount Tulaog, *Ramos & Edaño s. n.,* May 24, 1917, along small streams in damp forests.

This species is remarkable for its unusually large leaves, which attain a length of 55 cm in the specimens examined. It is further strikingly characterized by its short petioles, very large and conspicuous stipules, and its narrow partial inflorescences, the inflorescence consisting of three branches, their peduncular portions greatly elongated. Fruiting material will probably show it to belong in the section *Grumilea.*

**PSYCHOTRIA NAGAPATENSIS** sp. nov.

Frutex erectus, ramulis et petiolis et subtus foliis ad costa dense subadpresse castaneo-hirsutis, ramis tenuibus, glabris, ramulis tenuissimis, circiter 1 mm diametro; foliis chartaceis, oblongis ad oblongo-oblanceolatis, usque ad 5 cm longis, nitidis, acutis vel obtusis, vel leviter acuminatis, basi cuneatis, nervis utrinque circiter 6, subtus distinctis; fructibus terminalibus, paucis, fasciculatis vel valde depauperato-cymosis, brevissime pedicellatis, laevis, anguste obovoideis, circiter 6 mm longis.

An erect, much-branched shrub, the branches slender, glabrous, the branchlets very slender, densely castaneous-hirsute with short, subappressed hairs as are the petioles and the midrib on the lower surface of the leaves. Leaves chartaceous, oblong to oblong-oblanceolate, more or less brownish when dry, shining, 4 to 5 cm long, 1.3 to 2 cm wide, the apex acute, obtuse, or somewhat acuminate, base cuneate; lateral nerves 6 on each side of the midrib, slender, distinct on the lower surface, anastomosing, the reticulations lax, evanescent; petioles 5 to 7 mm long. Infructescences terminal, very short, the fruits few, either fascicled or in very greatly reduced cymes, the peduncle, when present, not exceeding 2 mm in length, 2 to 5 fruits at the tip of each branchlet; fruits narrowly obovoid, glabrous, dark-brown or black when dry, smooth, glabrous, shining, not at all ridged or sulcate, about 6 mm long, subsessile or very shortly pedicellate, the pedicels not exceeding 1 mm in length.

LUZON, Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33193 Ramos,* August 8, 1918, on dry slopes, altitude about 700 meters.

This species is well characterized by its small leaves and its fascicled or at most very depauperate-cymose, small, non-sulcate fruits. It apparently belongs in the section *Grumilea,* although the seeds are not sufficiently developed to determine this point. In the characters of its infructescence it approaches *Psychotria papillata* Merr., although it is not otherwise closely allied to this species, differing remarkably in its smaller, fewer-nerved, differently shaped leaves and entirely different indumentum.

PSYCHOTRIA OBSCURINERVIA sp. nov. § *Grumilea.*

Frutex scandens, glaber; foliis chartaceis ad subcoriaceis, in siccitate pallidis, usque ad 6.5 cm longis, oblongis, utrinque subaequaliter angustatis, apice obtusis ad latissime obtuseque acuminatis, basi cuneatis, nervis utrinque 5 vel 6, valde inconspicuis; infructescentiis terminalibus, pedunculatis, pyramidatis, usque ad 16 cm latis, diffusis, multifloris; fructibus anguste ellipsoideis, circiter 4.5 mm longis, laevis, pericarpio haud carnoso, seminibus plano-convexis, haud sulcatis, albumine ruminato.

A scandent, glabrous shrub, the branches terete, reddish-brown or brownish, 3 to 5 mm in diameter, smooth, their internodes 1 to 1.5 cm long. Leaves chartaceous to subcoriaceous, pale when dry, somewhat shining, oblong, 4 to 6.5 cm long, 1.5 to 2.5 cm wide, subequally narrowed to the cuneate base and to the obtuse or broadly and obtusely acuminate apex; lateral nerves 5 or 6 on each side of the midrib, very slender, obscure, the reticulations obsolete; petioles about 5 mm long; stipules caducous. Inflorescences terminal, peduncled, pyramidal, diffuse, many-flowered, 13 to 16 cm wide, about 10 cm long excluding the 5 to 6 cm long peduncle, the primary branches opposite, spreading, few, these branches at or above the middle, the branchlets opposite. Pedicels 1 to 2 mm long. Calyx about 1 mm long, truncate or obscurely 4-toothed. Corolla about 4.5 mm long, the lobes 2 mm long. Fruit narrowly ellipsoid, pale brownish when dry, not fleshy, about 4.5 mm long, smooth, not at all sulcate or ridged, the pericarp thin; pyrenes plano-convex; seeds plano-convex, not ridged, albumen somewhat ruminate.

LUZON, Ilocos Norte Province, between Bangui and Claveria, *Bur. Sci. 33077 Ramos,* August 30, 1918, in forests at low altitudes.

Among the scandent, glabrous Philippine species with peduncled, diffuse inflorescences the present one is readily distinguished by its very obscurely nerved leaves, the reticulations being obsolete, the lateral nerves very slender and obscure.

**PSYCHOTRIA PALLIDIFOLIA** sp. nov.

Frutex erectus, glaber; foliis firmiter chartaceis ad subcoriaceis, oblongis ad oblongo-lanceolatis, in siccitate pallidis, nitidis, usque ad 15 cm longis, acuminatis, basi acutis, nervis utrinque circiter 10, curvatis, anastomosantibus, utrinque cum reticulis perspicuis; paniculis usque ad 4 cm longis, e basi ramosis, ramis paucis; fructibus obovoideis, 6 ad 7 mm longis, longitudinaliter perspicue carinatis; pyrenis plano-convexis, dorso perspicue bicarinatis, albumine aequabile.

An erect glabrous shrub, the branches brownish, or the younger ones subolivaceous. Leaves firmly chartaceous to subcoriaceous, pale and shining when dry, of the same color on both surfaces, oblong to oblong-lanceolate, 9 to 15 cm long, 3 to 5 cm wide, subequally narrowed to the acute base and the distinctly acuminate apex; lateral nerves about 10 on each side of the midrib, curved, sometimes ascending, anastomosing, distinct on both surfaces as are the rather close reticulations; petioles 5 to 10 mm long. Panicles terminal, up to 4 cm long in fruit, with two primary lateral branches from the base, the flowers somewhat crowded on the primary branches. Fruits obovoid, 6 to 7 mm long, rather prominently sulcate and ridged when dry, their pedicels 1 to 2 mm long. Pyrenes plano-convex, prominently 2-keeled, the seeds conforming to the pyrenes, the albumen uniform, not at all ruminate.

CATANDUANES, Mount Mariguidon and vicinity of Cololbong, *Bur. Sci. 30510* (type), *30446, 30320 Ramos,* November and December, 1917, on forested slopes.

This species resembles the imperfectly known *Psychotria negrosensis* Elm., differing radically in the shape of its leaves. It is perhaps as closely allied to this species as to any other described form.

**PSYCHOTRIA PANAYENSIS** sp. nov.

Frutex erectus, inflorescentiis minute puberulis exceptis glaber; foliis oblongis ad oblongo-obovatis, membranaceis vel chartaceis, 15 ad 20 cm longis, apice breviter obtuse acuminatis, nervis utrinque 12 ad 14, perspicuis; paniculis brevibus, circiter 3 cm longis et 5 cm latis, ramis verticillatis; fructibus obovoideis, haud sulcatis, 7 mm longis, seminibus plano-convexis, albumine aequabile.

An erect shrub, glabrous except in minutely puberulent inflorescences, the indumentum obscure, usually castaneous. Leaves oblong to oblong-obovate, membranaceous to chartaceous, 15 to 20 cm long, usually 5 to 8 cm wide, or in the extreme form 10 cm wide, brownish or somewhat olivaceous when dry, base acute or slightly decurrent-acuminate, apex slightly obtuse-acuminate; lateral nerves 12 to 14 on each side of the midrib, rather distant, somewhat curved, prominent on the lower surface, anastomosing, the primary reticulations rather distinct and somewhat lax; petioles 2 to 3 cm long; stipules deciduous. Panicles terminal, 3 to 3.5 cm long, about 5 cm wide, branched from the base or shortly peduncled, the branches verticillate, spreading, the lower ones 2 to 2.5 cm long, each branch usually dichotomous or trichotomous above, the ultimate branchlets usually bearing about three white flowers, their pedicels 1 to 2 mm long. Calyx about 2 mm long and wide, obscurely 4-toothed, corolla-tube 3 mm long, the lobes oblong-ovate, reflexed, 2 mm long, throat bearded. Styles slender, 4 mm long. Fruits obovoid, not sulcate, glabrous, about 7 mm long, brown or black when dry. Seeds plano-convex, not rigid, the albumen not ruminate.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31198* (type), *31042 Ramos & Edaño,* April and May, 1918, in damp forests along small streams. *No. 31335* of the same collection unquestionably represents the same species, this being the form with leaves about 10 cm in width.

The alliances of this species are not entirely clear. It is sufficiently well characterized by its short, minutely puberulent inflorescences, the plants otherwise glabrous, associated with its obovoid fruits which are not ridged, and its seeds which are not at all ruminate.

**PSYCHOTRIA PIPERI** sp. nov.

Frutex scandens, inflorescentiis dense griseo-puberulis exceptis glaber; ramis ramulisque brunneis, teretibus; foliis oblongis ad oblongo-ovatis, chartaceis vel subcoriaceis, usque ad 14 cm longis, in siccitate brunneo-olivaceis, nitidis, basi rotundatis, apice acuminatis, nervis utrinque circiter 14, perspicuis; inflorescentiis terminalibus, paniculatis, pedunculatis, cum pedunculo circiter 16 cm longo; floribus extus griseo-puberulis, circiter 8 mm longis.

A scandent shrub, quite glabrous except the puberulent inflorescence. Branches and branchlets glabrous, smooth, terete, brown or reddish-brown, 4 to 5 mm in diameter. Leaves oblong to oblong-ovate, firmly chartaceous or subcoriaceous, 11 to 14 cm long, 5 to 7.5 cm wide, brownish-olivaceous when dry, the lower surface paler than the upper, both shining, base rounded, apex rather prominently acuminate; lateral nerves about 14 on each side of the midrib, curved-spreading, anastomosing near the margin, prominent, the primary reticulations lax, very distinct; petioles 1 to 2.5 cm long; stipules deciduous, the scars prominent. Inflorescence terminal, paniculate, including the peduncle about 16 cm long, the peduncle about 8 cm long, glabrous, the branchlets and flowers gray-puberulent, the branches few, the lower pair about 6 cm long, branched above the middle, the inflorescence about 11 cm wide. Flowers puberulent externally, about 8 mm long, pedicelled. Calyx about 2 mm in diameter, rather shallow, distinctly toothed. Corolla-tube slightly enlarged upward, about 5 mm long, the lobes oblong, obtuse, about 2.5 mm long.

MINDANAO, Surigao Province, Hinatuan, *C. V. Piper 513*, May 16, 1911. DINAGAT, *Bur. Sci. 35188 Ramos & Pascasio*. In forests at low altitudes.

This species is apparently allied to *Psychotria ramosissima* Elm. and *P. lianoides* Elm., and distinctly nearer the latter. It differs, however, among other characters, in its longer flowers and densely puberulent inflorescences.

### PSYCHOTRIA PYGMAEA sp. nov.

Frutex erectus, circiter 30 cm altus, parce ramosus, glaber; foliis chartaceis, oblongis ad oblongo-obovatis, usque ad 10 cm longis, nitidis, breviter petiolatis, acutis, basi cuneatis, nervis utrinque circiter 8, distinctis, reticulis obscuris vel subobsoletis; infructescentiis, fructibus exceptis, haud 1 cm longis, trichotomis, ramis brevissimis; fructibus oblongo-ellipsoideis, circiter 7 mm longis, breviter pedicellatis, longitudinaliter sulcatis; pyrenis plano-convexis, perspicue 4-carinatis, albumine aequabile.

An erect, sparingly branched, glabrous shrub or undershrub, about 30 cm high, the stems terete, not more than 4 mm in diameter. Leaves oblong, rarely somewhat oblong-obovate, chartaceous, shining, the upper surface usually olivaceous, the lower usually brown tinged with red when dry, 6 to 10 cm long, 2 to 3.5 cm wide, the apex acute, base gradually narrowed, cuneate; lateral nerves about 8 on each side of the midrib, slender but distinct, curved, obscurely anastomosing, the reticulations obscure or subobsolete; petioles 2 mm long or less;

stipules ovate, acuminate, about 4 mm long, deciduous, the stipular scar on the branchlets usually castaneous-villous. Infructescences terminal, solitary, less than 1 cm long without the fruits, 3-branched, the branches short, each bearing at its tip from 1 to 5 shortly pedicelled, oblong-ellipsoid, 7 mm long fruits. Bracteoles ovate-lanceolate, acuminate, about 3 mm long. Fruits dark-purple or black when fresh, castaneous when dry, longitudinally sulcate, their pedicels 1 mm long or less. Pyrenes plano-convex, prominently 4-keeled, the albumen uniform.

LUZON, Rizal Province, Mount Susong Dalaga, *Bur. Sci. 29271 Ramos*, August 14, 1917, in forests.

This species is well characterized by its small size, in size resembling *Psychotria repens* Elm. It differs radically from Elmer's species not only in its habit, but also in being entirely glabrous except for its pubescent stipular scars.

**PSYCHOTRIA SCABERULA** sp. nov.

Frutex erectus, inflorescentiis leviter hirsutis vel pubescens, foliis subtus scabridis; foliis chartaceis, oblongo-ellipticis ad elliptico-obovatis, olivaceis, 16 ad 20 cm longis, breviter acuminatis, basi decurrentibus, nervis utrinque circiter 15, perspicuis; inflorescentiiis circiter 3 cm longis, ramis primariis paucis, usque ad 2 cm longis, floribus sessilibus, in capitulis globosis circiter 1.5 cm diametro dispositis, calycis usque ad 8 mm longis.

An erect shrub or small tree, the inflorescences slightly hirsute or pubescent with short hairs, the leaves distinctly scabrid on the lower surface by scattered, short, stiff, projecting hairs. Leaves chartaceous, oblong-elliptic to elliptic-obovate, dark olivaceous when dry, 16 to 20 cm long, 7.5 to 11 cm wide, the apex shortly acuminate, the base somewhat decurrent, the upper surface smooth, glabrous, the lower surface distinctly hirsute with short hairs on the midrib and nerves and with short, projecting, stiff hairs from thickened bases on the epidermis; lateral nerves about 15 on each side of the midrib, distinct, the reticulations lax, not prominent; petioles about 4 cm long. Inflorescences terminal, 3 cm long or less, sparingly branched, the primary branches 2 cm long or less, somewhat hirsute, each bearing a rather dense, globose head of sessile flowers, about 1.5 cm in diameter. The calyces up to 8 mm long, the limb distinctly produced above the ovary.

DINAGAT, *Bur. Sci. 35159 Ramos & Pascasio*, May 11, 1919, in forests at low altitudes.

This species is apparently allied to *Psychotria velutina* Elm. which it closely resembles in many characters. It is distinguished, however, by its leaves being distinctly scabrous and not softly pubescent beneath, and by its longer, glabrous petioles.

**PSYCHOTRIA TRICARPA** sp. nov.

Frutex erectus, ramulis petiolisque castaneo-pubescentibus; foliis chartaceis, glabris, oblongo-obovatis, abrupte acuminatis, basi cuneatis, 8 ad 12 cm longis, nervis utrinque 10, perspicuis; fructibus paucis, terminalibus, sessilibus, ovoideis, in siccitate brunneis, 8 mm longis, haud sulcatis; albumine aequabile.

An erect shrub, the branchlets and petioles rather conspicuously pubescent with weak, short, somewhat crisped, spreading, castaneous hairs, the branches terete, glabrous, slender, the internodes 4 to 12 cm long. Leaves chartaceous, oblong-obovate, rather abruptly acuminate, the acumen short, acute, somewhat narrowed below to the cuneate base, 8 to 12 cm long, 3 to 6 cm wide, somewhat shiny and brownish when dry; lateral nerves about 10 on each side of the midrib, prominent on the lower surface, somewhat curved, distinctly anastomosing, the reticulations evident; petioles 1 to 2 cm long. Fruits sessile, usually 3 at the tip of each branchlet, ovoid, brown when dry, about 8 mm long, the pericarp rather thick, not at all sulcate. Seeds plano-convex, not sulcate or ridged, the albumen uniform.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31224 Ramos & Edaño,* May 17, 1918, in damp forests.

This species in the disposition of its fruits resembles *Psychotria euphlebia* Merr., from which it is very easily distinguished by its pubescence and its fewer-nerved leaves; in the present species the albumen is not at all ruminate while in *P. euphlebia* it is distinctly so.

## RANDIA Linnaeus

**RANDIA ROSTRATA** sp. nov.

Frutex vel arbor parva, glabra; foliis chartaceis, oblongis ad oblongo-lanceolatis, nitidis, 6 ad 11 cm longis, utrinque subaequaliter angustatis, basi cuneatis, apice tenuiter acuminatis, nervis utrinque plerumque 5, tenuibus, distinctis; fructibus axillaribus, plerumque solitariis, pedunculatis, anguste ellipsoideis, 12 ad 14 mm longis, utrinque angustatis, basi leviter acuminatis, apice rostratis, calycis dentibus linearis, 1.5 ad 2.5 mm longis, glabris.

A glabrous, unarmed shrub or small tree. Leaves chartaceous, oblong to oblong-elliptic or oblong-lanceolate, pale olivaceous and shining when dry, 6 to 11 cm long, 2 to 4 cm wide, subequally narrowed to the slenderly acuminate apex and the cuneate or somewhat decurrent base; lateral nerves usually 5 on each side of the midrib, slender, distinct, the reticulations lax, sometimes obsolete; petioles about 5 mm long; stipules lanceolate, acuminate, from a broadened base, about 3 mm long. Fruits axillary, usually solitary, peduncled, narrowly ellipsoid, 12 to 14 mm long, black when dry, the base narrowed, somewhat acuminate, the apex rather prominently rostrate, glabrous, crowned by the somewhat produced, rather narrow, cylindric calyx-tube and by the linear, 1.5 to 2.5 mm long calyx-teeth; pedicels 1.5 to 2.5 cm long, slender, their basal parts supplied with 1 or 2 pairs of small bracts.

BUCAS GRANDE, *Bur. Sci. 35102 Ramos & Pascasio,* June 11, 1919, in dry forests.

A species well characterized by its slenderly acuminate leaves and by its long-pedicelled, distinctly rostrate fruits. It somewhat resembles *Randia samalensis* Elm. but differs radically in its glabrous calyces, elongated pedicels, etc.

### TARENNA Gaertner

Many botanists have maintained *Webera* Schreber (1791) as the valid generic name for a rather ill-defined group of rubiaceous plants, consistently overlooking the fact that *Webera* Hedw. (1782), a valid and universally recognized genus of mosses, invalidates Schreber's use of the same name for a genus of the Rubiaceae. Schreber cited *Chomelia* Linn. as a synonym of his genus, but under our present rules of nomenclature *Chomelia* Linn. has no standing, and is, moreover, invalidated by *Chomelia* Jacquin. *Webera,* as defined by Schreber, has two-celled, two-seeded fruits, and hence cannot be a synonym of *Tarenna* Gaertner. *Tarenna* Gaertner [2] was based on a Ceylon specimen, the species being known to the natives as *tarennae.* While Gaertner specifically described the flowers as 4-merous, there is every reason to believe that this statement is an error, and that the plant he had in mind is the form described by Linnaeus as *Rondeletia asiatica* Linn., and described by Trimen [3] as *Webera corymbosa* Willd. Trimen gives *Rondeletia asiatica* Linn., *Ta-*

[2] Fruct. 1 (1788) 139, *t. 28.*
[3] Fl. Ceylon 2 (1894) 328.

*renna zeylanica* Gaertn., and *Stylocoryne webera* A. Rich. as synonyms; the proper specific name for the species would seem to be *Tarenna asiatica* (Linn.) O. Kuntze.

However, *Tarenna* is not the first name proposed for this group, as *Cupi* Adanson [4] is manifestly congeneric with Gaertner's *Tarenna.* This generic name, being objectionable in form, and being published without a binomial, has little claim to recognition, and I believe that it should be discarded in favor of *Tarenna.* Later (1830) de Candolle modified the name to *Cupia. Cupi* Adanson was based wholly on *Cupi* Rheede [5] which is manifestly a *Tarenna* as here interpreted.

Hooker f.[6] retained the generic name *Webera,* but included under it two sections: *Euwebera,* including those plants having two or more ovules in each cell of the ovary, namely *Tarenna;* and *Pseudixora,* those species having but one ovule in each cell of the ovary. It is exceedingly illogical to include in the Rubiaceae one-ovulate and several-ovulate species in the same genus, and it is not considered that Hooker's description of the species is correct. King [7] recognized that the grouping of *Euwebera* and *Pseudixora* in a single genus is incorrect, retained *Webera* for Hooker's section *Euwebera,* and placed the species of *Pseudixora* under *Stylocoryna* Cav.; however, the type and sole species described by Cavanille under *Stylocoryna* is a *Randia, R. racemosa* (Cav.) F.-Vill., so that *Stylocoryna* King non Cav. becomes a synonym of *Tarenna.* The general conclusions regarding *Tarenna, Cupi,* and *Cupia* are in conformity with those of Wernham.[8]

The Philippine species of *Tarenna* are as follows:

TARENNA ACUMINATA sp. nov.

Arbor parva, circiter 5 m alta, partibus junioribus et inflorescentiis et foliis subtus ad costa nervisque perspicue ciliatis; foliis oblongo-oblanceolatis, membranaceis, olivaceis, nitidis, usque ad 17 cm longis, apice tenuiter acute acuminatis, basi cuneatis, nervis utrinque 9 ad 12, perspicuis; infructescentiis brevibus, circiter 3 cm longis, breviter pedunculatis, corymbosis;

[4] Fam. Pl. 2 (1763) 158.

[5] Hort. Malabar. 2 (1679) 37, *t. 23.*

[6] Fl. Brit. India 3 (1880) 101.

[7] Journ. As. Soc. Bengal 72[2] (1903) 108.

[8] Wernham, H. F., The nomenclature of Tarenna, Journ. Bot. 51 (1913) 58, 59.

fructibus globosis, circiter 7 mm diametro, seminibus 4, concavo-convexis.

A small tree, about 5 m high, the younger parts, inflorescences, and leaves on the midrib and nerves beneath prominently ciliate with pale or subferruginous, rather stiff hairs. Branches terete, dark reddish-brown, glabrous, the branchlets slender, somewhat angled or sulcate. Leaves membranaceous to subchartaceous, olivaceous and shining when dry, oblong-oblanceolate, 10 to 17 cm long, 3 to 5 cm wide, narrowed upward to the slenderly and sharply acuminate apex, and below to the cuneate base, the upper surface glabrous, smooth, or the midrib slightly pubescent, the lower surface somewhat paler, conspicuously ciliate on the midrib and nerves, and with fewer hairs on the reticulations; lateral nerves 9 to 12 on each side of the midrib, prominent, curved-ascending, anastomosing, the reticulations lax, distinct; petioles ciliate, 1 to 1.5 cm long; stipules lanceolate or ovate-lanceolate, acuminate, about 8 mm long, sparingly ciliate on the back. Infructescences terminal, short, ciliate, about 3 cm long, trichotomous, the peduncles 1.5 cm long or less. Fruits few, globose, dark-brown or black when dry, glabrous or with few scattered hairs, about 7 mm in diameter. Seeds 4, somewhat triangular in outline, thick, concavo-convex.

LUZON, Apayao Subprovince (not Cagayan Province as indicated on the herbarium label), between Tamoc and Dabba, *Bur. Sci. 13904* (type), *13958 Ramos,* February, 1912.

This species is well characterized by its short infructescences, its few fruits, its slenderly and sharply acuminate leaves, and its indumentum.

**TARENNA CATANDUANENSIS** sp. nov.

Frutex subglaber; foliis oblongis ad oblongo-ellipticis, firmiter chartaceis, usque ad 30 cm longis, supra laevis, glabris, nitidis, pallide olivaceis, subtus parcissime puberulis et minutissime scaberulis, apice tenuiter acute acuminatis, basi acutis, nervis utrinque circiter 9, valde perspicuis, arcuato-anastomosantibus; infructescentiis leviter pubescentibus, cymosis, pedunculatis, circiter 8 cm longis; fructibus globosis, 8 ad 10 mm diametro, glabris, in siccitate rugosis; seminibus 4 ad 6, angulatis, subcupulatis, rugosis.

A nearly glabrous shrub, the branches obscurely angled or somewhat compressed. Leaves firmly chartaceous, oblong to oblong-elliptic, 17 to 30 cm long, 6.5 to 10.5 cm wide, base acute, apex slenderly and sharply acuminate, the upper surface smooth, glabrous, pale-olivaceous, shining, the lower very slightly puberulent and minutely scaberulous, of about the same color as the upper surface; lateral nerves 9 on each side of the midrib, very prominent, curved, arched-anastomosing, the reticulations prominent, lax; petioles about 3 cm long. Infructescences about 8 cm long and about as wide, trichotomously branched, the peduncles about 2 cm long, slightly pubescent, the bracts lanceolate, acuminate, 5 to 7 mm long. Fruits yellow when fresh, when dry pale to black, rugose, glabrous, globose, 8 to 10 mm in diameter, each containing from 4 to 6 seeds, the seeds irregular, angular, somewhat cupped, rugose.

CATANDUANES, *Bur. Sci. 30387 Ramos*, December 2, 1917, in forests along Santo Domingo River at low altitudes.

The alliance of this species is with *Tarenna scaberula* Merr., from which it is distinguished by its larger, differently shaped, fewer-nerved leaves, which are smooth and glabrous above and only very obscurely puberulent beneath. Like *T. scaberula* it belongs in the group that in facies simulates *Pavetta*, but is distinguished from *Pavetta* in having several seeds in each cell.

**TARENNA ELONGATA** sp. nov.

Frutex glaber vel leviter pubescens; foliis lanceolatis, coriaceis, 17 ad 30 cm longis, utrinque subaequaliter angustatis, basi cuneatis, apice acuminatis, nervis utrinque 7 vel 8, adscendentibus, perspicuis; inflorescentiis usque ad 12 cm longis, ramis paucis; calycis leviter urceolatis, circiter 4 mm longis, corollae tubo brevissimo, lobis circiter 8 mm longis; fructibus globosis, 8 mm diametro, seminibus 10 ad 12, angulatis.

A shrub, about 2 m high, glabrous or sparingly pubescent, the branches reddish-brown. Leaves lanceolate, coriaceous, 17 to 30 cm long, 3 to 6 cm wide, olivaceous, somewhat shining, subequally narrowed to the distinctly acuminate apex and to the cuneate or somewhat decurrent base; lateral nerves usually 7 or 8 on each side of the midrib, curved, ascending, prominent; petioles 2 to 3.5 cm long; stipules ovate to lanceolate, acuminate, up to 1 cm long. Inflorescences terminal, peduncled or branched from the base, up to 12 cm long, the branches few, spreading, glabrous or somewhat pubescent, few-flowered. Calyx somewhat urceolate, about 4 mm long, the corolla-tube very short, the lobes up to 8 mm in length. Fruits globose, black when dry, shining, about 8 mm in diameter, 10- to 12-seeded, the seeds angular, about 4 mm long.

DINAGAT, *Bur. Sci. 35218 Ramos & Pascasio,* May 11, 1919, in forests at low altitudes. *Bur. Sci. 35076 Ramos & Pascasio,* from the neighboring island of Bucas Grande, undoubtedly represents the same species; this number differs from the type in having its leaves somewhat pubescent beneath.

A species well characterized by its coriaceous, lanceolate, rather few-nerved leaves, which attain a length of 30 cm and are from 3 to 6 cm in width.

**TARENNA LITTORALIS** sp. nov.

Frutex 3 ad 5 m altus, inflorescentiis cinereo-pubescentibus exceptis glaber; foliis oblongis ad oblongo-ellipticis, subcoriaceis, usque ad 17 cm longis, in siccitate nitidis, utrinque nigricantibus, basi acutis vel acuminatis, apice distincte acuminatis, nervis utrinque 8 ad 10, distinctis; inflorescentiis corymbosis circiter 6 cm longis, multifloris, breviter pedunculatis vel e basi ramosis, cinereo-pubescentibus; floribus albis, 5-meris, calycis extus dense pubescentibus, 3 mm longis, truncatis vel subtruncatis; corollae tubo circiter 6 mm longo, lobis oblongis, obtusis, 6 mm longis; fructibus globosis, nigris, nitidis, circiter 6 mm diametro, seminibus circiter 5, subtriangularibus, concavo-convexis.

A shrub, 3 to 5 m high, glabrous except the inflorescence. Branches grayish or brownish, terete, the branchlets somewhat compressed or sulcate. Leaves when dry rather uniformly blackish, and shining on both surfaces, subcoriaceous, oblong to oblong-elliptic, 10 to 17 cm long, 4 to 7 cm wide, subequally narrowed to the acute or acuminate base and to the distinctly acuminate apex, the acumen acute or subobtuse; lateral nerves 8 to 10 on each side of the midrib, distinct; petioles 1 to 3 cm long; stipules broadly ovate, obtuse to acute, 5 to 8 mm long. Inflorescences terminal, corymbose, conspicuously cinereous-pubescent with short appressed hairs, in fruit becoming nearly glabrous, about 6 cm long and about as wide as long, shortly peduncled or branched from the base. Flowers numerous, white, 5-merous, their pedicels up to 3 mm long, the bracteoles less than 1 mm long. Calyx pubescent, ovoid or slightly urceolate, 3 mm long, truncate or subtruncate, the teeth, if at all evident, very short and obtuse. Corolla-tube about 7 mm long, glabrous, the throat densely villous, the lobes oblong, obtuse, 6 mm long, 2.5 mm wide. Anthers 6 mm long. Style and stigma 15 mm long, the style pubescent in the middle, the stigma cylindric, grooved. Fruits globose, black and shining when dry, about 6 mm in diameter, each containing about 6 seeds, the seeds dark-brown, shining, suborbicular to roughly triangular in outline, concavo-convex.

PALAWAN, Apulit Island, Taytay Bay, *Merrill 9418* (type), May, 1913; near Puerto Princesa, *For. Bur. 3533, 4523, 7460 Curran,* January and June, 1906. DUMARAN, *Bur. Sci. 21623 Escritor,* August, 1913. APO (Mindoro Strait), *Merrill 412,* December, 1902. UBIAN, *Merrill 5390,* October, 1906. LUZON, Pangasinan Province, Bolinao, *For. Bur. 8380 Curran & Merritt,* December, 1907: Zambales Province, *Bur. Sci. 5105 Ramos,* December, 1907.

This species grows in forests and thickets immediately back of the beach, all the specimens cited being rather remarkably uniform in appearance and characters. Its alliance is with *Tarenna fragrans* Koord. & Val., from which it differs in numerous characters, notably in its much shorter flowers, glabrous corolla, and fewer-nerved leaves. Some of the specimens cited above are the basis of the Philippine reference of *Stylocoryne webera* Wallich.[9] It is apparently more closely allied to *Tarenna asiatica* (Linn.) O. Kuntze than it is to *T. fragrans* Koord. & Val.

**TARENNA NITIDA** sp. nov.

Arbor circiter 5 m alta, inflorescentiis parcissime pubescentibus exceptis glabra; foliis chartaceis, olivaceis, nitidis, oblongo-ellipticis ad ovato-ellipticis, usque ad 12 cm longis, utrinque acuminatis, nervis utrinque circiter 6, distinctis; inflorescentiis circiter 4.5 cm longis, brevissime pedunculatis vel e basi ramosis, paucifloris; floribus circiter 2 cm longis, 5-meris, corollae tubo 6 mm longo, lobis oblongis, apiculatis, 10 mm longis; loculis biovulatis.

A small tree, about 5 m high, entirely glabrous except the slightly pubescent inflorescence. Branches terete, brownish or grayish, the branchlets usually olivaceous, slender, and often sulcate. Leaves chartaceous, olivaceous and prominently shining on both surfaces when dry, oblong-elliptic to ovate-elliptic, 8 to 12 cm long, 4 to 5.5 cm wide, subequally narrowed to the distinctly acuminate apex and the decurrent-acuminate base; lateral nerves about 6 on each side of the midrib, prominent, anastomosing; petioles about 1 cm long; stipules broadly ovate, obtuse to acuminate, about 6 mm long. Inflorescences corymbose, few-flowered, sessile or shortly peduncled, about 4.5 cm long including

[9] Elm. Leafl. Philip. Bot. 1 (1906) 33.

the flowers, the rachis, branches, pedicels, and calyces uniformly pubescent with short, scattered, appressed, cinereous hairs. Flowers white, 5-merous. Calyx 5 mm long, the limb produced 3 mm above the ovary and conspicuously 5-toothed, the teeth lanceolate, acuminate, 1.5 mm long. Corolla-tube 6 mm long, somewhat pubescent within, bearded at the throat, the lobes 5, oblong, apiculate, 10 mm long, 3.5 mm wide. Anthers straight, slender, 10 mm long. Ovary 2-celled; cells 2-ovuled; style and stigma 1.8 cm long, slightly exserted, the style pubescent, the stigma grooved.

NEGROS, San Carlos, *For. Bur. 23388 Contreras,* May 16, 1914, in thickets at low altitudes.

This species is well characterized by being entirely glabrous except its sparingly appressed-pubescent inflorescences. Its alliance is with *Tarenna eucrantha* (Elm.) Merr. and *T. palawanensis* (Elm.) Merr., but it is very distinct from both.

**TARENNA OBTUSIFOLIA** sp. nov.

Frutex vel arbor parva, inflorescentiis parce pubescentibus exceptis glaber; foliis oblongis, obtusis, usque ad 13 cm longis, in siccitate nigricantibus, nitidis, nervis utrinque circiter 8, distinctis; inflorescentiis terminalibus, corymbosis, breviter pedunculatis vel e basi ramosis; floribus 5-meris, calycis distincte 5-dentatis, corollae tubo glabro, 5 mm longo, lobis distincte brevioribus, circiter 3.5 mm longis; stylis glabris.

A shrub or small tree, glabrous except the inflorescence which is sparingly cinereous-pubescent with short appressed hairs. Branches terete, brownish, the branchlets rather distinctly 4-angled and often sulcate. Leaves firmly chartaceous to subcoriaceous, black and shining on both surfaces when dry, oblong, 7 to 13 cm long, 3 to 5 cm wide, base somewhat acuminate, often inequilateral, the apex obtuse, usually rounded, never acuminate; lateral nerves about 8 on each side of the midrib, distinct, the reticulations lax, slender; petioles 2 to 3 cm long; stipules broadly ovate, acuminate, about 5 mm long. Inflorescences terminal, shortly peduncled or branched from the base, about 6 cm long and about as broad, sparingly appressed-pubescent with short hairs. Calyx ovate-urceolate, 2 mm long, slightly pubescent, with 5 distinct, broad, short teeth. Corolla-tube glabrous, 5 mm long, the throat densely villous, the lobes 5, oblong, obtuse, 3.5 mm long and 1.6 mm wide. Anthers 3 mm long. Style and stigma 11 mm long, the style glabrous, the stigma cylindric, slender, obscurely grooved; ovules several in each cell.

BOHOL, Guindulman, *Bur. Sci. 1257 McGregor,* June 26, 1906.

This species is distinguished from *Tarenna maritima* Merr., to which it is manifestly allied, not only by its obtuse leaves, but also by its smaller flowers, the corolla-lobes distinctly shorter than the tube, much smaller anthers, and its glabrous styles.

**TARENNA STENANTHA** sp. nov.

Arbor parva, partibus junioribus et inflorescentiis cinereo-pubescentibus; foliis oblongis ad oblongo-ellipticis, usque ad 22 cm longis, utrinque leviter et sparse pubescentibus, acuminatis, basi acutis vel decurrento-acuminatis, nervis utrinque circiter 15, papyraceis, in siccitate olivaceis, nitidis; inflorescentiis corymbosis, breviter pedunculatis, multifloris; floribus tenuibus, numerosis, corollae tubo circiter 7 mm longo et 1.5 mm diametro, extus pubescentibus; ovulis circiter 16.

A tree, about 5 m high, the younger parts, inflorescences, and leaves more or less pubescent with short, usually cinereous hairs. Branches brownish, somewhat wrinkled, glabrous, terete or obscurely rounded-angled, about 5 mm in diameter, the internodes 1 cm long or less, the young branchlets nearly as stout, more definitely angled, and rather densely pubescent. Leaves chartaceous, olivaceous, shining, oblong to oblong-elliptic, 15 to 22 cm long, 5 to 7.5 cm wide, subequally narrowed to the acuminate apex and acute to decurrent-acuminate base, both surfaces sparingly pubescent with short, scattered hairs; lateral nerves about 15 on each side of the midrib, prominent, anastomosing; petioles 1 to 1.5 cm long, pubescent; stipules lanceolate, or lanceolate from an ovate base, slenderly long-acuminate, sparingly pubescent, about 1 cm long. Inflorescences terminal, corymbose, rather densely cinereous-pubescent with short hairs, shortly peduncled, about 6 cm long, rather wider than long, many-flowered. Flowers white, slender, their pedicels 2 to 3 mm long, the bracts scattered, linear, about 1 mm long. Calyx ovoid, pubescent, 1.5 mm long, the teeth 5, triangular, acute, 0.3 mm long. Corolla-tube slender, cylindric, pubescent, 7 mm long, 1.5 mm in diameter, the lobes 5, oblong-elliptic, obtuse, 4 mm long and 2 mm wide. Anthers linear, 3.5 mm long. Style and stigma about 17 mm long, exserted, the style pubescent above the glabrous base, the stigma entire or shortly 2-lobed at the apex. Ovary 2-celled; ovules about 8 in each cell.

LUZON, Tayabas Province, Umiray, *Bur. Sci. 29003 Ramos & Edaño* (type), June 6, 1917, in forests along Umiray River at low altitudes.

While the present species does not present any remarkably distinctive vegetative characters, its flowers are unusually small and slender for the genus. It does not appear to be very closely allied to any other described form.

To this species I also refer the following specimens, which were mostly identified by Mr. Elmer with *Stylocoryne macrophylla* Bartl.: LUZON, Bataan Province, Mount Mariveles, *Whitford 1245, For. Bur. 2573, 3030 Borden:* Rizal Province, *For. Bur. 2691 Ahern's collector:* Batangas Province, *Bur. Sci. 22328 Ramos.* MINDORO, *For. Bur. 3726 Merritt.*

**TARENNA INCERTA** Koord. & Val. Meded. Lands Plantent. 59 (1902) 269; Koord. Exkursionsfl. Java 2 (1912) 259; Koord.-Schum. Syst. Verzeich. Herb. Koord. $1^3$ (1912) 81; Koord. Atlas Baumarten Java 3 (1915) *f. 535.*

*Tarenna zeylanica* Koord. & Val., op. cit. 82, non Gaertn.

*Randia wallichii* Merr. in Philip. Journ. Sci. 3 (1908) Bot. 266; 5 (1910) Bot. 389; Elm. Leafl. Philip. Bot. 3 (1911) 1004, non Hook. f.

*Randia ebracteata* Elm. Leafl. Philip. Bot. 4 (1912) 1354.

*Tarenna ebracteata* Elm. op. cit. 5 (1913) 1898.

*Randia fitzalani* Elm. Leafl. Philip. Bot. 1 (1906) 31; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 130, non F. Muell.

This species is of very wide distribution in the Philippines, and is somewhat anomalous in *Tarenna* in the reduction in the number of ovules. In most cases there appear to be but one or two ovules in a cell; but some of the Philippine material, that I cannot otherwise distinguish, presents fruits with as many as five seeds. The usual number of seeds is apparently two in each fruit. I am by no means convinced that *Tarenna incerta* Koord. & Val. is the oldest valid specific name for this species, but feel certain that the Philippine synonyms are properly placed under it. I have a specimen from Burma, *Prazer 79,* that is a close match for *Koorders 39255, 39260, 6770,* from Java, of which I have specimens before me. I refer here the following Philippine specimens:

BATAN ISLANDS, Batan, *For. Bur. 15277 Agudo.* LUZON, Cagayan Province, *For. Bur. 14771 Darling:* Isabela Province, *Bur. Sci. 7992 Ramos:* Abra Province, *Bur. Sci. 7078 Ramos:* Bontoc Subprovince, *Vanoverbergh 3902:* Benguet Subprovince, *For. Bur. 18204 Curran, Merritt, & Zschokke, Elmer 5927, 5994, Merrill Phil. Pl. 773, 1729:* Ilocos Norte Province, *For. Bur. 22987 Adduru:* Ilocos Sur Province, *For. Bur. 5664 Klemme:* Nueva Vizcaya Province, *For Bur. 18415 Alvarez, Bur. Sci. 11494, 20164 McGregor:* Pangasinan Province, *For. Bur. 19460 Agama, For.*

*Bur. 8327 Curran & Merritt, For. Bur. 14395 Villamil, For. Bur. 13494 Medina, Bur. Sci. 4834 Ramos, Merrill Phil. Pl. 2072:* Zambales Province, *Hallier, Merrill 2988:* Bataan Province, *For. Bur. 17581 Curran, For. Bur. 1517, 3031 Borden, For. Bur. 2279, 2996 Meyer, For. Bur. 586 Barnes, Whitford 360, 1017, 1057, 1239, Williams 594:* Batangas Province, *For. Bur. 7635, 7751 Curran & Merritt, Bur. Sci. 24101 Ramos & Deroy:* Camarines Province, *For. Bur. 10685 Curran:* Sorsogon Province, *Bur. Sci. 23677 Ramos:* Rizal Province, *For. Bur. 2095 Ahern's collector, Loher 6330, Bur. Sci. 13767 Ramos.* JOLO, *Clemens 9340.* PALAWAN, *Merrill 9593, Elmer 13114* (type of *Randia ebracteata* Elm.=*Tarenna ebracteata* Elm.).

Considering the wide geographic distribution of the species and its great altitudinal range, from about sea level to an altitude of about 1,400 meters, this species is remarkably uniform.

**TARENNA CUMINGIANA** (Vid.) Elm. Leafl. Philip. Bot. 5 (1913) 1898.

*Webera cumingiana* Vid. Phan. Cuming. Philip. (1885) 119, 178.

The type of this species is *Cuming 865,* from Tayabas Province, Luzon. Its alliance is manifestly with *Tarenna mollis* (Wall.) Valeton and *T. winkleri* Valeton. It is represented by the following specimens: LUZON, Sorsogon Province, *For. Bur. 10600 Curran, Bur. Sci. 23393 Ramos.* LEYTE, *Bur. Sci. 15318 Ramos, Wenzel 152, 531, 592, 794, 844.* BILIRAN, *Bur. Sci. 18950 McGregor.* MINDANAO, Surigao Province, *Piper 207, 511, Sanchez, Wenzel 1804, For. Bur. 22838 Ponce, Ahern 313, 700:* Agusan Subprovince, *For. Bur. 24505 Sabino, Elmer 13363.*

**TARENNA ARBOREA** (Elm.) Elm. Leafl. Philip. Bot. 4 (1912) 1359.

*Randia arborea* Elm. Leafl. Philip. Bot. 3 (1911) 1005.

MINDANAO, Davao District, *Elmer 10978,* June, 1909.

The alliance of this species is manifestly with the Philippine *Tarrena stenantha* Merr. and the Javan *T. polycarpa* Koord. & Val.

**TARENNA FRAGRANS** (Blume) Koord. & Val. in Meded. Lands Plantent. 59 (1902) 88; Elm. Leafl. Philip. Bot. 4 (1912) 1358.

*Stylocoryna fragrans* Blume Bijdr. (1826) 982.

*Webera fragrans* Hook. f. Fl. Brit. India 3 (1880) 103.

PALAWAN, *Elmer 12768,* March, 1911.

The identification of this Philippine specimen with *Tarenna fragrans* Koord. & Val. is merely approximate and, in the absence of flowers, connot be considered as certain; it differs from typical

Javan material in some particulars, but may be referable to this species.

**TARENNA EUCRANTHA** (Elm.) comb. nov.

*Pavetta eucrantha* Elm. Leafl. Philip. Bot. 3 (1911) 1015.
*Stylocoryne incerta* Elm. op. cit. 1 (1908) 33, non *Tarenna incerta* Koord. & Val.

The type of this is *Elmer 12494,* from Sibuyan. The same species is represented by the following specimens: LEYTE, *Elmer 7054,* distributed as *Pavetta indica* Linn. SAMAR, *Bur. Sci. 24389, 24559 Ramos.* MINDANAO, Zamboanga District, *Ahern 384:* Lanao District, *Mrs. Clemens 435, 584, 652,* and three sheets without number: Agusan Subprovince, *Weber 1006, Elmer 13988.*

This species strongly simulates *Pavetta,* but the flowers are constantly 5-merous, the calyx-teeth are unusually prominent, the ovary cells are 2-ovulate, and the fruits are usually 4-seeded. On account of its ovule and seed characters it cannot be referred to *Pavetta.*

**TARENNA PALAWANENSIS** (Elm.) comb. nov.

*Pavetta palawanensis* Elm. Leafl. Philip. Bot. 4 (1912) 1344.

In a previous paper on Philippine Rubiaceae [10] I interpreted this species on the basis of the specimens there cited, giving a description based on the specimens. At that time I had not seen Mr. Elmer's material; the species I described is totally different from that characterized by Mr. Elmer, and is *Pavetta phanerophlebia* Merr., page 478. The type of *Pavetta palawanensis* Elm. is *Elmer 12940,* and an examination of it shows that the ovary cells are biovulate, and that it is hence a *Tarenna,* not a *Pavetta.* The flowers that I have seen are 5-merous, not 4-merous as described by Elmer. The corolla-tube is less than 4 mm long, and the lobes are about 6 mm in length. The species is very closely allied to *Tarenna eucrantha* (Elm.) Merr., but its flowers are less than one-half as large as are those of the latter species, while its calyx teeth are much less prominent.

**TARENNA SCABERULA** (Merr.) comb. nov.

*Pavetta scaberula* Merr. in Philip. Journ. Sci. 10 (1915) Bot. 118.

A reëxamination of this species shows that the ovary cells are biovulate, while the fruits are normally 4-seeded. The

[10] Philip. Journ. Sci. 10 (1915) Bot. 117.

species is also represented by the following specimens, from LUZON: Laguna Province, San Antonio, *Bur. Sci. 13524, 20506, 23815 Ramos:* Camarines Province, *For. Bur. 22632 Alvarez.*

DOUBTFUL SPECIES

STYLOCORYNA (?) MACROPHYLLA Bartl. ex DC. Prodr. 4 (1830) 377; Miq. Fl. India Bat. 2 (1856) 206.

This species was based on a specimen collected in Sorsogon Province, Luzon, by Haenke. I have not seen the type, and the description is wholly inadequate; it may be a *Tarenna*, or it may appertain to some entirely different genus. The specimens referred here by local botanists, Elmer[11] and Merrill,[12] are *Tarenna stenantha* Merr.

Extra-Philippine Indo-Malayan species of *Tarenna* are as follows:

**TARENNA ASIATICA** (Linn.) O. Kuntze Rev. Gen. Pl. (1891) 278.

*Rondeletia asiatica* Linn. Sp. Pl. (1753) 172.
*Webera corymbosa* Willd. Sp. Pl. 1 (1798) 1224; Hook. f. Fl. Brit. India 3 (1880) 102, cum. syn.
*Tarenna zeylanica* Gaertn. Fruct. 1 (1788) 139, *t. 28, f. 3.*

India and Ceylon.

**TARENNA ANGUSTIFOLIA** (King) comb. nov.

*Stylocoryna angustifolia* King in Journ. As. Soc. Bengal 72[2] (1903) 199.

Perak.

**TARENNA ADPRESSA** (King) comb. nov.

*Stylocoryna adpressa* King in Journ. As. Soc. Bengal 72[2] (1903) 200.

Singapore, Johor, Pahang.

**TARENNA MAINGAYI** (Hook. f.) comb. nov.

*Stylocoryna maingayi* King in Journ. As. Soc. Bengal 72[2] (1903) 200.
*Webera maingayi* Hook. f. Fl. Brit. India 3 (1880) 103.

Malacca, Perak, Negri Sembilan, Johor.

**TARENNA COSTATA** (Miq.) comb. nov.

*Stylocoryna costata* Miq. Fl. Ind. Bat. Suppl. (1862) 218.

Malacca, Selangor, Sumatra.

[11] Leafl. Philip. Bot. 1 (1906) 33.
[12] Philip. Journ. Sci. 1 (1906) Suppl. 129.

TARENNA FRAGRANS (Blume) Koord. & Val. Meded. Lands Plantent. 59 (1902) 77.

*Stylocoryna fragrans* Blume Bijdr. (1826) 982.
*Webera fragrans* Hook f. Fl. Brit. India 3 (1880) 103.

Malay Peninsula, Banca, Borneo, Java.

TARENNA LAXIFLORA (Blume) Koord. & Val. Meded. Lands Plantent. 59 (1902) 80.

*Stylocoryna laxiflora* Blume Bijdr. (1826) 983.
*Tarenna confusa* Val. ex Koord.-Schum. Syst. Verzeich. Herb. Koord. $1^3$ (1912) 79.

Java.

TARENNA MOLLIS (Wall.) Valeton in Engl. Bot. Jahrb. 44 (1909) 558.

*Stylocoryna mollis* Wall. Cat. (1848) no. 8454, nomen nudum.
*Webera mollis* Hook. f. Fl. Brit. India 3 (1880) 104.

Malay Peninsula.

TARENNA SAMBUCINA (A. Gray) Warb. in Engl. Bot. Jahrb. 13 (1891) 432.

*Stylocoryna sambucina* A. Gray in Proc. Am. Acad. 4 (1859) 309.

New Guinea to Polynesia.

TARENNA NIGRESCENS Warb. in Engl. Bot. Jahrb. 13 (1891) 431.

New Guinea.

TARENNA GLABRA Merr. in Philip. Journ. Sci. 9 (1914) Bot. 149.

Marianne Islands.

TARENNA BORNEENSIS Valeton in Engl. Bot. Jahrb. 44 (1910) 557.

Borneo.

TARENNA WINKLERI Valeton in Engl. Bot. Jahrb. 48 (1912) 112.

Borneo.

TARENNA GIBBSIAE Wernham in Journ. Linn. Soc. Bot. 42 (1914) 93.

Borneo.

TARENNA POLYCARPA (Miq.) Valeton ex Koord.-Schum. Syst. Verzeich. Herb. Koord. $1^3$ (1912) 82.

*Stylocoryna polycarpa* Miq. Fl. India. Bat. 2 (1857) 204.

Java.

TARENNA PUMILA (Hook. f.) comb. nov.

*Webera pumila* Hook. f. Fl. Brit. India 3 (1880) 103.

India.

**TARENNA BURUENSIS** (Miq.) comb. nov.

*Stylocoryna buruensis* Miq. Fl. Ind. Bat. 4 (1868) 129.

Buru.

By no means all of the species described under *Stylocoryna* can be referred to *Tarenna,* but in numerous cases type or authentic material must be studied before the various species can be disposed of, due to imperfect or incomplete original descriptions. A number of forms characterized by Miquel may or may not be referable to *Tarenna;* unfortunately he does not indicate for several species whether the cells are one- or many-ovulate. *Stylocoryna densiflora* Miq. is certainly a *Randia,* probably a synonym of *Randia racemosa* (Cav.) F.-Vill.; *S. albituba* Miq. and *S. lucida* Miq. are apparently forms of *Tarenna fragrans* Koord. & Val. If Miquel included only pluriovulate species under *Stylocoryna,* then perhaps the following species will eventually have to be transferred to *Tarenna: S. celebica* Miq., *S. forsteniana* Miq., *S. orophila* Miq.

### PAVETTA Linnaeus

In the Philippines various species have been described under *Webera,* some one-ovulate, some several-ovulate. The several-ovulate species I have here placed under *Tarenna,* and after considerable study of the available material, I have concluded that the one-ovulate species are better treated as *Pavetta;* otherwise the only alternative would be the proposal of a new generic name for those forms placed by Hooker f. under the section *Pseudixora* (non *Pseudixora* Miq.). So far as our Philippine forms are concerned, they closely approximate typical *Pavetta,* differing in only trivial and unimportant characters; in aspect, color when dry, stipules, inflorescences, indumentum (when present), and flowers such forms as *Webera pubescens* Vid. and *Webera meyeri* Merr. are *Pavetta*-like in all respects; they differ from typical *Pavetta* in having 5-merous flowers, and the styles slightly grooved and, while prominently exserted, not so greatly elongated. The difference in the number of floral parts is unimportant as in several species of typical *Pavetta* 4- and 5-merous flowers are found on the same specimen. Not having seen specimens of many of the Indian specimens of *Webera* placed by Hooker f. in the section *Pseudixora,* I am not prepared to state that they should be transferred to *Pavetta,* but merely suspect that this is the proper disposition of them; it is certainly the proper disposition of the Philippine species having *Pseudixora* characters.

**PAVETTA ELMERI** sp. nov.

Frutex circiter 2 m altus, perspicue ciliato-pubescens; foliis obovatis, membranaceis, usque ad 12 cm longis, obtusis ad obtuse acuminatis, basi acutis, nervis utrinque circiter 12, distinctis; inflorescentiis brevissime pedunculatis, confertis, multifloris, 3 ad 4 cm longis, dense ciliato-villosis; floribus 4-meris, corollae tubo 5 ad 6 mm longo.

A shrub, about 2 m high, the leaves and inflorescences conspicuously ciliate-pubescent. Branches terete, smooth, pale, shining, the very young growing parts densely ciliate with pale hairs. Leaves (immature) membranaceous, obovate, 9 to 12 cm long, 5 to 7 cm wide, brown or black when dry, the apex obtuse to obtusely acuminate, the base acute, both surfaces prominently ciliate-pubescent especially on the midrib and lateral nerves; lateral nerves about 12 on each side of the midrib, prominent; petioles densely pubescent, 1 cm long or less; stipules broadly ovate, acuminate, about 5 mm long, pubescent. Inflorescences densely many-flowered, 3 to 4 cm long, short-peduncled, the axis, branches, pedicels, and calyces densely and uniformly ciliate-pubescent with cinereous hairs. Calyx 2 to 2.5 mm long, the teeth 4, oblong, acute, nearly 1 mm long. Corolla-tube 5 to 6 mm long, glabrous externally, inside somewhat pubescent, the lobes 4, oblong, about 4 mm long. Anthers 4 mm long. Ovary 2-celled, cells 1-ovulate; style and stigma glabrous, at least 10 mm long.

LUZON, Benguet Subprovince, Twin Peaks, *Elmer 6394*, May 31, 1914.

This species is well characterized by its rather dense and characteristic ciliate indumentum; its obovate leaves; its densely crowded, relatively short flowers; and its glabrous styles. It belongs in the group with *Pavetta indica* Linn., but does not appear to be very closely allied to that species.

**PAVETTA MULTINERVIA** sp. nov.

Frutex 3 ad 5 m altus, inflorescentiis parcissime puberulis exceptis glaber; ramulis compressis vel angulatis; foliis lanceolatis ad oblongo-lanceolatis, membranaceis vel chartaceis, usque ad 25 cm longis, in siccitate nigris, nitidis, utrinque acuminatis, nervis utrinque circiter 15, perspicuis; inflorescentiis pedunculatis, trifidis 11 ad 13 cm longis; floribus 5-meris, calycis tubo 6 mm longo, lobis oblongo-oblanceolatis, circiter 12 mm longis.

A shrub, 3 to 5 m high, entirely glabrous except the sparingly puberulent inflorescence. Branchlets brown or black when dry, compressed or angled. Leaves membranaceous to chartaceous, uniformly black and shining on both surfaces when dry, lanceolate to oblong-lanceolate, 18 to 25 cm long, 5 to 7 cm wide, subequally narrowed to the acuminate base and apex; lateral nerves about 15 on each side of the midrib, prominent, slightly curved, anastomosing, the reticulations lax; petioles 2 to 3 cm long; stipules broadly ovate, abruptly acuminate, about 5 mm long. Panicles terminal, peduncled, black when dry, sparingly puberulent, 11 to 13 cm long, 3-branched, the flowers somewhat crowded toward the ends of the branches. Flowers white, black when dry, 5-merous, their pedicels 6 mm long or less. Calyx slightly puberulent, urceolate, about 2.5 mm long, truncate or very obscurely 5-toothed. Corolla-tube glabrous, not even bearded at the throat, about 6 mm long, the lobes oblong-oblanceolate, obtuse, about 12 mm long and 2.5 mm wide. Anthers 10 mm long. Ovary 2-celled, cells 1-ovulate; style and stigma about 2.2 mm long, the former slightly pubescent in the median part.

MINDANAO, Zamboanga District, Port Banga, *For. Bur. 9013 Whitford & Hutchinson,* November 29, 1907, on forested ridges, altitude about 30 meters.

This species is strongly characterized by its elongated, many-nerved leaves; its peduncled, trifid inflorescences; its 5-merous flowers; and short corolla-tube which is not bearded at the throat, the lobes being twice as long as the tube. The plant is entirely glabrous except the sparingly puberulent inflorescence.

PAVETTA WILLIAMSII sp. nov.

Arbor circiter 4.5 m alta, molliter pubescens; foliis in siccitate nigris, nitidis, membranaceis vel chartaceis, usque ad 25 cm longis, oblongo-ellipticis ad oblongo-obovatis, acuminatis, basi acutis, nervis utrinque circiter 7, perspicuis; inflorescentiis corymbosis, laxis, multifloris, usque ad 10 cm longis et 15 cm latis; floribus 4-meris, corollae tubo circiter 11 mm longo, lobis oblongis, obtusis, 8 mm longis.

A small tree, about 4.5 m high, the branchlets, lower surface of the leaves, and inflorescences softly pubescent, the leaves, flowers, and inflorescences black when dry. Branches terete, smooth, brownish or grayish, glabrous. Leaves oblong-elliptic to oblong-obovate, membranaceous to chartaceous, 15 to 25 cm long, 6 to 9 cm wide, rather prominently acuminate, base acute, black and shining when dry, the upper surface glabrous, or when young sparingly puberulent, the lower surface softly pubescent with spreading, pale or dirty-brown hairs, especially on the midrib and nerves; lateral nerves about 7 on each side of the midrib, prominent, curved, ascending, anastomosing, the reticulations very lax; petioles pubescent, 2 to 3 cm long; stipules oblong-ovate, acute or somewhat acuminate, pubescent, about 6 mm long. Panicles ample, sessile or shortly peduncled, corymbose, up to 10 cm long and 15 cm wide, black when dry, softly pubescent. Flowers white, 4-merous, black when dry, the pedicels slender, up to 1 cm in length. Calyx 2.5 to 3 mm long, densely pubescent, somewhat urceolate, the teeth 4, acute, triangular, 0.5 mm long. Corolla-tube glabrous, 11 mm long, the lobes 4, oblong, obtuse to subacute, about 8 mm long and 3 mm wide. Ovary 2-celled, cells 1-ovulate; style and stigma slender, 3.5 cm long, glabrous.

MINDANAO, Davao District, Mount Apo, *Williams 2631* (type), April 5, 1905, *Copeland 1249,* April, 1904, altitude about 900 meters, known to the Bagobos as *sikarig.*

This species falls in the group with *Pavetta indica* Linn., but is distinguished by its indumentum, its much larger leaves, and ample, lax inflorescences.

**PAVETTA SUBFERRUGINEA** sp. nov.

Frutex circiter 3 m altus, ramulis junioribus, subtus foliis ad costa nervisque et inflorescentiis perspicue subferrugineo-pubescentibus; foliis chartaceis, olivaceis, oblongis ad oblongo-lanceolatis vel oblongo-ellipticis, usque ad 16 cm longis, tenuiter acuminatis, basi cuneatis, nervis utrinque circiter 9, supra plus minusve impressis, subtus perspicuis; inflorescentiis laxis, sessilibus vel subsessilibus; floribus 4-meris, corollae tubo 1.8 cm longo, utrinque glabro, fauce haud barbato, lobis subellipticis, 6 mm longis.

A shrub, about 3 m high, the younger parts, lower surface of the leaves, and inflorescences conspicuously and softly subferruginous-pubescent with spreading hairs. Branches pale, smooth, glabrous, terete. Leaves chartaceous, olivaceous and shining when dry, oblong to oblong-lanceolate or oblong-elliptic, 10 to 16 cm long, 3 to 5 cm wide, the apex rather slenderly acuminate, base cuneate, the upper surface glabrous or somewhat harsh from the few, short, stiff hairs, the midrib pubescent, the lower surface rather densely subferruginous-pubescent on the midrib and lateral nerves, with scattered hairs on the epidermis; lateral nerves about 9 on each side of the midrib, somewhat impressed on the upper surface, prominent beneath, anastomosing, the reticulations lax, prominent; petioles pubescent, 1 to 1.8 cm long;

stipules broadly ovate, acuminate, pubescent, about 6 mm long. Inflorescences sessile or subsessile, lax, the axis and branches 3 cm long or less, subferruginous-pubescent, the whole inflorescence including the slender styles about 12 cm in diameter. Flowers white, 4-merous. Calyx pubescent, 3 mm long, ovoid, the teeth 4, ovate, acute, 0.8 mm long. Corolla-tube slender, glabrous on both surfaces, about 18 mm long, the throat not bearded, the lobes 4, subelliptic, obtuse, 6 mm long, 3.5 mm wide. Anthers 6 mm long, spirally twisted. Ovary 2-celled, cells 1-ovulate; style and stigma very slender, glabrous, 4.5 cm long.

PALAWAN (Paragua), Separation Point, *Merrill 831,* February 18, 1903, in forests at low altitudes.

This species resembles *Pavetta indica* Linn., but differs in so many characters that it can scarcely be treated as a form or variety of that species. Notable characters are its subferruginous indumentum, longer flowers, its corolla glabrous on both surfaces and not bearded at the throat, and its greatly elongated styles.

**PAVETTA INDICA** Linn. Sp. Pl. (1753) 110.

*Pavetta barnesii* Elm. Leafl. Philip. Bot. 1 (1906) 27; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 132.

This species is represented by about fifty different collections from all parts of the Philippines. Now that so much material is available, and further that we have abundant material from India, China, and Malasia for comparison, I fail to see how *Pavetta barnesii* Elm. can be distinguished from the typical form of *Pavetta indica* Linn. I interpret the type of *Pavetta indica* Linn. as the Ceylon plant, Fl. Zeyl. No. 56, and an excellent description of this typical form is given by Trimen.[13] The type of *Pavetta barnesii* Elm. closely matches *Thwaites 1663* from Ceylon.

**PAVETTA PHANEROPHLEBIA** Merr. nom. nov.

*Pavetta palawanensis* Merr. in Philip. Journ. Sci. 10 (1915) Bot. 117, cum. descr., non Elm.

As noted under *Tarenna,* to which *Pavetta palawanensis* Elm. pertains, my interpretation of *Pavetta palawanensis* Elm. was based on Mr. Elmer's description which, as to the flowers, is incomplete and somewhat erroneous. An examination of his type shows that the ovary cells of his species are biovulate, so

[13] Fl. Ceyl. 2 (1894) 349.

that *Pavetta palawanensis* Elm. must be removed from this genus; see *Tarenna palawanensis* Merr., page 471. The description of *Pavetta palawanensis* Merr. (non Elm.) cited above is typified by *Bur. Sci. 326 Bermejos,* this specimen thus becoming the type of *Pavetta phanerophlebia* Merr.

**PAVETTA LUZONIENSIS** (Vid.) comb. nov.

*Webera luzoniensis* Vid. Phan. Cuming. Philip. (1885) 119, 179, Rev. Pl. Vasc. Filip. (1886) 152; Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 133; Elm. Leafl. Philip. Bot. 1 (1906) 40.

The type of this is *Cuming 1323* from Cagayan Province, Luzon. It is one of the forms having 5-merous flowers, falling in the group that some botanists have placed in *Webera.* While the specimens cited below present some variations from the type, they are in most respects fairly uniform and I believe all represent Vidal's species:

LUZON, Cagayan Province, *Adduru 66, 120, 192, 264:* Apayao Subprovince, *Bur. Sci. 28146 Fénix:* Pangasinan Province, *Alberto 29:* Nueva Vizcaya Province, *Merrill 142:* Bataan Province, *Merrill 1488, 2505, 2524, 3260, Elmer 6661, Leiberg 6160, For. Bur. 2188 Meyer:* Laguna Province, *Gates & Quisumbing 7536, Elmer 8316, Baker 3291:* Batangas Province, *For. Bur. 21527 Tamesis:* Rizal Province, *Bur. Sci. 6776 Robinson, Guerrero 27, Bur. Sci. 10894 Ramos.* PALAWAN, *Bur. Sci. 701 Foxworthy.*

**PAVETTA MEYERI** (Elm.) Elm. Leafl. Philip. Bot. 3 (1911) 1015.

*Ixora meyeri* Elm. Leafl. Philip. Bot. 1 (1908) 68.
*Webera meyeri* Merr. in Philip. Journ. Sci. 1 (1906) Suppl. 133.
*Tarenna meyeri* Elm. Leafl. Philip. Bot. 5 (1913) 1898.

This species is still known only from a single collection, *For. Bur. 2764 Meyer,* from Mount Mariveles, Bataan Province, Luzon. The flowers are not mature, so that the styles are not exserted as is the case with *Pavetta* in full anthesis. The specimen is, however, a typical *Pavetta;* it cannot possibly be referred to *Tarenna* as the cells are but 1-ovulate.

**PAVETTA PUBESCENS** (Bartl.) comb. nov.

*Stylocoryna pubescens* Bartl. ex DC Prodr. 4 (1830) 377.
*Webera* sp. Vid. Phan. Cuming. Philip. (1885) 42.

I have seen two specimens of Haenke's collection on which this species was based, one in the Prague Herbarium, in flower, and one in the Herbarium of the Missouri Botanical Garden, in bud. Haenke's specimen was unquestionably from northern Luzon, as it is closely matched by several specimens from this region and is not known from any other locality. *Cuming 1236*, from Ilocos Norte Province, is an excellent match for the type. *Bur. Sci. 7626, 7667 Ramos* and *For. Bur. 15222 Merritt & Darling,* from the same province, also represent the same species. The flowers are typical of *Pavetta,* differing from the majority of the species in the genus in being 5-merous rather than 4-merous; the fruits are 2-celled, each cell with a single cupped seed.

### TIMONIUS de Candolle

**TIMONIUS AURICULATUS** sp. nov.

Species *T. hirsuto* affinis, differt foliis basi perspicue auriculato-cordatis. Frutex vel arbor parva, ramulis et foliis et inflorescentiis perspicue hirsutis; foliis chartaceis ad coriaceis, in siccitate brunneis, oblongo-obovatis, 9 ad 20 cm longis, apice rotundatis ad late acutis, deorsum angustatis, basi perspicue auriculato-cordatis, nervis utrinque circiter 9; inflorescentiis pedunculatis, dichotomis, 3 ad 5 cm longis, ramis primariis 1 ad 2 cm longis; floribus paucis, sessilibus, calycis truncatis, perspicue longe hirsutis.

A shrub or small tree, the branchlets, leaves, and inflorescences prominently hirsute with long, spreading, brownish hairs, the branches glabrous, terete. Leaves chartaceous to coriaceous, brown when dry, oblong-obovate, 9 to 20 cm long, 3.5 to 9.5 cm wide, the apex rounded to broadly acute, the base narrowed and distinctly auriculate-cordate, 8 to 40 mm across the basal lobes; lateral nerves about 9 on each side of the midrib, rather slender, distinct, curved-ascending, the reticulations evident; petioles 4 to 10 mm long, hirsute; stipules deciduous. Inflorescences in the uppermost axils, peduncled, 3 to 5 cm long, dichotomous, the peduncles up to 3 cm in length, the two branches 1 to 2 cm in length. Flowers usually 4 to 6 on each branch, sessile, the calyces 1.5 to 2 mm in length, truncate, densely hirsute with long, spreading, pale brownish hairs up to 4 mm in length. Corolla not seen.

DINAGAT, *Bur. Sci. 35190* (type), *35212 Ramos & Pascasio,* May, 1919. In forests at low altitudes.

This species is manifestly closely allied to Timonius hirsutus (Elm.) comb. nov. (*Greenia hirsuta* Elm., *Timonius trichophorus* Merr.), from which it is at once distinguished by the auriculate-cordate leaf bases. The indumentum on the present species is very characteristic, consisting of long, spreading, pale brownish hairs, these being rather densely disposed on the branchlets and inflorescences, scattered on both surfaces of the leaves and here more abundant on the midrib and nerves, especially on the lower surface. In age the upper surface of the leaf becomes glabrous or nearly so. In the type specimen the leaf base across the basal auricles is 1 cm in width or less; in the second specimen cited, which is sterile, the leaf bases are from 3 to 5 cm in width.

### UROPHYLLUM Wallich

**UROPHYLLUM CAUDATUM** sp. nov.

Frutex glaber; foliis firmiter chartaceis, oblongis ad oblongo-lanceolatis, 6 ad 8 cm longis, basi acutis, apice tenuiter caudato-acuminatis, nervis utrinque plerumque 5, perspicuis, curvatis; fructibus axillaribus solitariis vel binis, globosis, 5 mm diametro; pedicellis 7 ad 10 mm longis.

A glabrous shrub, the branchlets slender. Leaves firmly chartaceous, oblong to oblong-lanceolate, 6 to 8 cm long, 2 to 3 cm wide, base acute, apex slenderly caudate-acuminate; lateral nerves usually 5 on each side of the midrib, prominently curved, distinct, anastomosing, the reticulations rather close, evident; petioles 1 to 1.5 cm long, stipules narrowly oblong, blunt, about 5 mm long. Fruits axillary, solitary or in pairs, globose, about 5 mm in diameter, crowned by the obscurely toothed calyx limb; pedicels 7 to 10 mm long, usually with a pair of small bracteoles at the base.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33348 Ramos,* August 20, 1918, on forested slopes, altitude 900 meters.

This species is apparently most closely allied to *Urophyllum luzoniense,* from which it is easily distinguished by its thinner, caudate-acuminate, much fewer-nerved leaves.

**UROPHYLLUM AFFINE** sp. nov.

Frutex perspicue ciliato-villosis; foliis chartaceis, oblongis ad oblongo-lanceolatis, 13 ad 17 cm longis, tenuiter subcaudato-acuminatis, nervis utrinque circiter 12, perspicuis, utrinque plus minusve villosis; floribus ☿ solitariis, ♂ fasciculatis, breviter pedicellatis, dense villosis, calycis 4-dentatis, corollae lobis 6, anguste oblongis, 3 mm longis, extus villosis.

A polygamous shrub, the branches, branchlets, petioles, stipules, flowers and the leaves on both surfaces, especially on the midrib and nerves, ciliate-villous. Leaves chartaceous, oblong to oblong-lanceolate, 13 to 17 cm long, 4 to 6.5 cm wide, usually grayish when dry, base acute to rounded, apex slenderly subcaudate-acuminate, the upper surface and often the margins sparingly ciliate-villous, the lower surface with more numerous and similar hairs on the midrib, nerves, and primary reticulations; lateral nerves about 12 on each side of the midrib, curved, anastomosing, prominent on the lower surface as are the primary reticulations; petioles 7 to 18 mm long, very densely ciliate-villous; stipules narrowly lanceolate, densely villous, about 2 cm long. Perfect flowers solitary, their pedicels 2 mm long or less, the subtending bracts narrowly lanceolate, densely villous, 2 to 3 mm long. Calyx densely villous, obscurely 4-toothed, about 4 to 5 mm long. Corolla-tube glabrous, 2 mm long, the lobes 6, narrowly oblong, villous externally, about 3 mm long, the throat densely bearded. Staminate flowers in axillary fascicles, densely villous, their pedicels 2 to 3 mm long, calyx about 5 mm in diameter, shallowly cup-shaped, villous, 4-toothed. Corolla-tube 2 mm long, the lobes oblong-lanceolate, similar to those of the perfect flowers. Stamens 6.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci 28482, 28716* (type) *Ramos & Edaño,* May, 1917, on forested slopes apparently at low altitudes; the same species is represented by *Bur. Sci. 29917 Ramos & Edaño,* from Mount Tulaog which is not far from Mount Binuang.

All three specimens cited above were tentatively identified as *Urophyllum lucbanense* Elm. to which the present species is manifestly allied but from which it is easily distinguished by its larger leaves, its much denser indumentum, longer petioles, and very densely villous flowers.

**UROPHYLLUM PANAYENSE** sp. nov.

Frutex, ramis glabris, ramulis floribusque leviter pubescens; foliis chartaceis, oblongis ad oblongo-ellipticis, 10 ad 16 cm longis, basi acutis, apice perspicue acuminatis, nervis utrinque circiter 15, perspicuis; floribus fasciculatis et in cymis brevibus dispositis, corollae lobis 6, oblongis, glabris, calycis leviter pubescentibus.

A shrub, the growing parts of the branchlets and the flowers more or less pubescent. Branches terete, glabrous. Leaves oblong to oblong-elliptic, firmly chartaceous, 10 to 16 cm long, 3.5 to 6 cm wide, grayish when dry, the younger ones slightly appressed-pubescent on the midrib and nerves beneath, soon becoming glabrous, subequally narrowed to the acute base and rather prominently acuminate apex, the acumen blunt; lateral nerves about 15 on each side of the midrib, prominent on the lower surface, curved, anastomosing, the reticulations distinct; petioles 1.5 to 2 cm long; stipules oblong to oblong-lanceolate, about 1.5 cm long, more or less appressed-hirsute on the back. Flowers sometimes in axillary fascicles, sometimes in short-peduncled, few-flowered, bracteate cymes, both types occurring on the same branches; bracts when present oblong to lanceolate, 6 to 12 mm long, more or less hirsute; pedicels somewhat hirsute, 3 to 5 mm long. Calyx ovoid, somewhat hirsute, obscurely toothed, about 4 mm long. Corolla-tube about 3 mm long, the lobes 6, oblong, recurved, glabrous, 3.5 mm long, the throat bearded, stamens 6, the anthers about 1 mm long.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31421 Ramos & Edaño* (type), May 22, 1918, in forests along small streams. Nos. *30819* and *31105* of the same collectors from the same locality apparently represent the same species, although the last two differ in a few details from the type.

**UROPHYLLUM QUADRIBRACTEOLATUM** sp. nov.

Frutex 2 ad 3 m altus, molliter villosis; foliis chartaceis vel membranaceis, oblongis ad oblongo-lanceolatis, 10 ad 15 cm longis, apice subcaudato-acuminatis, nervis utrinque 9 ad 12, perspicuis, supra, costa exceptis, glabra; floribus solitariis, pedicellatis 1 ad 2 mm longis, bracteolis 4 verticillatis lineari-oblongis instructis, calycis dense villosis, circiter 6 mm longis, corollae lobis 6, extus villosis.

An erect shrub, 2 to 3 m high, the branches, branchlets, flowers and leaves on the lower surface softly villous, the internodes 5 to 10 cm long. Leaves chartaceous or membranaceous, oblong to oblong-lanceolate, 10 to 15 cm long, 3 to 4.5 cm wide, the upper surface glabrous except for the slightly pubescent midrib, grayish when dry, base acute, apex slenderly subcaudate-acuminate; lateral nerves 9 to 12 on each side of the midrib, somewhat ascending, curved, not anastomosing except toward the apex, prominent on the lower surface, the reticulations distinct; petioles 7 to 12 mm long, rather densely pubescent; stipules linear-oblong, pubescent, about 1 cm long. Flowers axillary, solitary, their pedicels densely pubescent, 1 to 2 mm long, bearing a whorl of four, linear-oblong, pubescent, 4 to 5 mm long bracteoles, the pedicel extended about 1 mm above the bracteole. Calyx 6 mm long, densely villous, 4-lobed, the lobes ovoid, obtuse, 2.5 mm long. Corolla-tube 0.4 mm long, the lobes 6, lanceolate, acuminate, villous, about 2.5 mm long, throat bearded. Stamens 6. Style 2 mm long, 6-cleft.

LUZON, Apayao Subprovince, Ngagan, *Bur. Sci. 28161 Fénix*, May 8, 1917, in damp forests.

This species was originally identified as *Urophyllum lucbanense* Elm., but it is not closely allied to that species. It is easily distinguished by its solitary pedicellate flowers, the pedicels being supplied with a whorl of four narrow, elongated, free bracteoles.

### WILLIAMSIA Merrill

**WILLIAMSIA PANAYENSIS** sp. nov.

Frutex erectus plus minusve molliter cinereo-villosis; foliis membranaceis ad chartaceis, oblongis, usque ad 24 cm longis, perspicue acuminatis, supra glabris vel subglabris, subtus ad costa nervisque molliter villosis, nervis utrinque 16 ad 20, perspicuis; floribus ☿ solitariis, sessilibus, ♂ fasciculatis, bracteolis involucrantibus dense villosis, exterioribus 4-lobatis, 3 ad 4 mm diametro, interioribus profunde 4-lobatis, vel segmentis liberis, oblongo-ovatis, 3.5 ad 5 mm longis; calycis dense villosis, 4-lobatis; corollae lobis 6 vel 7, oblongis, 4 ad 4.5 mm longis.

An erect shrub, the branches, flowers, petioles, and leaves on the midrib and nerves beneath softly cinereous-villous. Leaves membranaceous to chartaceous, oblong, 16 to 24 cm long, 6 to 9 cm wide, grayish-olivaceous when dry, the upper surface ultimately glabrous, the lower surface softly villous on the midrib and nerves, base acute to obtuse, apex rather prominently acuminate; lateral nerves 16 to 20 on each side of the midrib, prominent on the lower surface, curved, anastomosing, the reticulations distinct; petioles densely villous, 1.5 to 2.5 cm long; stipules narrowly oblong, densely villous, about 2 cm long. Flowers polygamous, the perfect ones usually solitary, sessile or subsessile, the staminate ones in few-flowered fascicles. Perfect flowers subtended by two series of densely villous bracts, the outer series forming a deeply lobed cup, 3 to 4 mm in diameter, the inner series larger, cleft nearly or quite to the base into four, oblong-ovate, acuminate lobes, 3.5 to 5 mm long. Calyx densely villous, the lobes 4, ovate to oblong-ovate, somewhat acuminate, 4 mm long. Corolla-tube 3 mm long, the lobes 6 or 7, white, oblong, acuminate, 4 to 4.5 mm long, densely villous externally, the throat densely bearded, the stamens 6 or 7. Staminate flowers smaller than the perfect ones but otherwise similar. Fruits globose, about 1 cm in diameter, rather densely villous.

PANAY, Capiz Province, Jamindan, *Bur. Sci. 31043* (type), *31310, 31315 Ramos & Edaño,* April and May, 1918, in damp forests along small streams.

This species is readily distinguished from the others described in the genus by its indumentum and especially by its densely villous bracteoles and flowers. The bracteoles are deeply 4-cleft, the inner series with free or nearly free lobes. It has much the appearance of certain forms of *Urophyllum* but has the involucriform double series of bracteoles characteristic of *Williamsia.*

**WILLIAMSIA LONGISTIPULA** sp. nov.

Frutex erectus, plus minusve ciliato-villosus; foliis membranaceis, oblongo-lanceolatis, usque ad 27 cm longis, supra glabris, tenuiter caudato-acuminatis, nervis utrinque circiter 17, perspicuis, subtus ciliato-villosis; floribus axillaribus, fasciculatis, villosis, bracteolis involucrantibus membranaceis, villosis, exterioribus 3 mm diametro, profunde 4-lobatis, interioribus subquadratis, 4 ad 5 mm latis, angulis leviter acuminatis; fructibus ovoideis, villosis, circiter 8 mm longis.

A shrub, 2 to 3 m high, the branchlets, stipules, flowers and leaves on the midrib and nerves beneath ciliate-villous, the older branches glabrous or nearly so, the internodes 3 to 6 cm long. Leaves membranaceous, oblong-lanceolate, pale when dry, 23 to 27 cm long, 6 to 7.5 cm wide, the upper surface entirely glabrous, base acute, apex slenderly caudate-acuminate; lateral nerves about 17 on each side of the midrib, prominent on the lower surface, curved, ascending, arched-anastomosing close to the margin, the reticulations rather lax, distinct, these sparingly ciliate-villous as are the nerves and midrib; petioles 1 to 1.5 cm long; stipules narrowly lanceolate, 3 to 4 cm long. Flowers axillary, fascicled, villous, the basal, cuplike bracteoles membranaceous, villous, the outer one about 3 mm in diameter, deeply 4-lobed, the lobes lanceolate-acuminate, the inner one nearly square, 4 to 5 mm wide, the corners acuminate. Fruits ovoid, about 6-celled, villous, about 8 mm long, sessile or nearly so, the persistent calyx lobes 4, broadly ovate, rounded or obtuse, about 3 mm long.

MINDANAO, Butuan Subprovince, Agusan River at Waloe, *Merrill 7287,* October 2, 1910, in damp forests, altitude about 50 meters.

This species is most closely allied to *Williamsia panayensis* Merr., from which it is distinguished by its longer stipules, its caudate-acuminate leaves, and by its entirely different involucral bracts.

# LOW-SUN PHENOMENA IN LUZON

## II. ZENITH OBSERVATIONS OF DAWN, BAGUIO, 1920

By WILLARD J. FISHER

*Assistant Professor of Physics, University of the Philippines*

In a previous paper[1] I have made an attempt to determine a lower limit to the extent of the atmosphere by noting at a known geographical position the time when the zenithal region becomes perceptibly blue. It was there mentioned that this blue coloration is preceded by a pale light spreading upward from the lower parts of the Zodiacal Light, and that the artificial illumination of the lower hazy air by the light of Manila prevents there any consistent observations of this "pale dawn."

April 17–18, 1919, from the summit of Mount Santo Tomas, elevation 2,258 meters, near Baguio, Benguet, I observed that faint stars were visible at very small angular altitudes; and that the haze of the lower air extended only to a height of about 1,500 meters, because a mountain 1,590 meters high projected slightly above the haze; so it was evident that from such a station in the Mountain Province the zenith passage of the pale dawn might be observed with fair accuracy. During a visit to Baguio, April 10 to May 2, 1920, made for this and related purposes, I was unfortunately prevented from visiting Santo Tomas; but from a station on the Outlook Drive, called Outlook Point on Bach's Map of the City of Baguio, I made six morning observations of this phenomenon—nearly all that it was possible to make between the new moon of April 19 and the full moon of May 3, for strato-cumulus and cirro-stratus clouds spoiled some mornings.

In the previous paper it was shown that the presence of the Zodiacal Light near the zenith was a hindrance to the prompt perception of the blue color at the zenith, while the same location of the Milky Way had less influence. But I found that the brilliancy of the Galaxy in the zenith sky of Outlook Point quite outshone the pale silvery light whose appearance I was to ob-

[1] Fisher, W. J., Philip. Journ. Sci. (1920) 151.

serve; fortunately, the Galaxy stretched across the heavens in a plane oblique to the direction of the sun, so that after three mornings I was able to estimate the moment of zenith passage with some accuracy and consistency.

The watch, etc., were the same as used previously. The watch was checked twice on most days of my stay in Baguio; always by the telegraph time signals at 11 o'clock in the morning when they did not fail, which they sometimes did; again about 6 in the afternoon by the pendulum clock of the Meteorological Observatory on Mount Mirador; and a proper allowance was made for the temperature changes shown by the two comparisons to have a considerable effect on the watch.

Measurement on the map showed the station at Outlook Point to be nearly in the same latitude as Mount Mirador, and about 2 minutes 8 seconds eastward; so I took for its coördinates, Latitude North 16° 25.0′, Longitude East 8 hours 2 minutes 32 seconds; its height is not essential, but is marked as 1,464 meters, or very nearly at the upper limit of the lower haze. That this limit was still about 1,500 meters was shown repeatedly by sighting on the setting sun with a Locke hand level supported on a camera tripod at Mount Mirador, where the station barometer cistern is stated by the observers to be 1,512.5 meters high. The sun, which had been very brilliant, plunged quite suddenly into the haze just as it passed the sighting line of the level.

Rejecting the three practice observations, the table shows the results, computed with four-place logarithms, and retaining tenths of minutes, though these are not significant.

| Date, 1920. | Hour east 120°. | Sun's altitude. | Sidereal time. |
|---|---|---|---|
| | *H. m. s.* | ° ′ | *H. m. s.* |
| April 23 | 4 33 9 | −15 43.1 | 18 38 4 |
| 24 | 4 31 48 | −15 51.6 | 18 40 38 |
| 25 | 4 31 20 | −15 48.0 | 18 44 7 |
| Mean | | −15 47.6 | |

Lower limit to atmospheric extent, $H \geqq$ 211.0 kilometers; which may be compared with 181.6 kilometers, the largest value deducible from the data of the previous paper, and with 70 kilometers, deduced by others from horizon observations of dawn and twilight.

# PHILIPPINE TERMITES COLLECTED BY R. C. McGREGOR, WITH DESCRIPTIONS OF ONE NEW GENUS AND NINE NEW SPECIES

By MASAMITSU OSHIMA

*Of the Government Institute of Science, Formosa*

FOUR PLATES

During 1917 and 1918 Mr. R. C. McGregor, of the Bureau of Science, Manila, made extensive collections of termites in Luzon and Panay in order to get some further knowledge of the Philippine termite fauna. Among the species obtained are the following nine which seem to be new to science:

*Calotermes* (*Neotermes*) *lagunensis*.
*Rhinotermes* (*Schedorhinotermes*) *bidentatus*.
*Termitogetonella* g. nov. *tibiaoensis*.
*Odontotermes mediodentatus*.
*Eutermes* (*Eutermes*) *castaneus*.
*Eutermes* (*Eutermes*) *las-piñasensis*.
*Eutermes* (*Rotunditermes*) *culasiensis*.
*Eutermes* (*Grallatotermes*) *panayensis*.
*Capritermes paetensis*.

It is a striking fact that the majority of the species in the Panay collection are quite different from those hitherto known from Luzon. Therefore, it is reasonable to suppose that the Philippine termite fauna may be extraordinarily rich, since the larger part of the Islands is unexplored.

*Coptotermes formosanus*, the commonest termite in Formosa and in South China, is here recorded from the Philippine Islands for the first time. This species is a formidable pest to wooden structures and wood products.

Here I express my hearty thanks to Mr. McGregor, by whose courtesy I was able to examine the collections.

## PROTERMITIDÆ

### CALOTERMITINÆ

### Genus CALOTERMES Hagen

**Calotermes (Neotermes) malatensis** Oshima. Plate 1, fig. 1.

*Calotermes (Neotermes) malatensis* OSHIMA, Philip. Journ. Sci. § D 12 (1917) 221 (Luzon, Manila, Malate).

LUZON, Manila, Malate, October 10, 1917.

*Remarks.*—A single specimen (imago).

**Calotermes (Neotermes) lagunensis** sp. nov. Plate 1, fig. 2; Plate 3, figs. 1 and 2; Plate 4, fig. 1.

*Imago.*—Unknown.

*Soldier.*—Head reddish brown; anteclypeus yellowish white; labrum yellow; antennæ amber-colored; mandible black-brown, proximal part becoming paler; pronotum yellowish; abdomen milk-white. Head sparingly pilose; sternites and abdominal tergites roughly covered with spiny hairs.

Head cylindrical, sides nearly straight and parallel, posterior border rounded; forehead gradually inclined anteriorly; antennæ 15-jointed, first joint cylindrical, exceedingly large, second joint shorter than third, fourth joint as long as second, other joints ovoid, subequal in length; no rudimental eyes; fontanelle not present; anteclypeus trapezoidal, nearly one-fourth as long as broad; postclypeus not separated from forehead, with a series of spiny hairs along its anterior border; labrum tongue-shaped, slightly longer than broad, with a small number of long hairs at the tip; mandibles rather stout, with piercing incurved tip; right mandible with two triangular teeth, subequal in size, left mandible with six teeth, apical two subequal, sharply pointed, third exceedingly low, fourth molarlike, its cutting surface concave, fifth broad and low, the last one triangular, sharply pointed; pronotum as broad as head, subreniform, anterior border nearly straight, posterior border obscurely bilobed, sides converging posteriorly; mesonotum much narrower than pronotum; metanotum a little larger than mesonotum.

| | mm. |
|---|---|
| Length of body | 9.00–11.00 |
| Length of head, with mandibles | 3.93– 4.53 |
| Length of head, without mandibles | 2.67– 3.20 |
| Width of head | 2.13– 2.40 |
| Width of pronotum | 2.13– 2.40 |
| Length of pronotum | 1.00– 1.13 |

*Worker.*—Head yellowish; thorax and abdomen milk-white. Head and sternites sparingly pilose; abdominal tergites with two transverse series of spiny hairs.

Head spherical; anterolateral corners of postclypeus brown; antennæ 15-jointed, second joint nearly as long as third, fourth joint ring-shaped, about half as long as third, fifth joint a little longer than fourth; pronotum nearly as broad as head, quadrilateral, anterior and posterior borders nearly straight, lateral borders slightly convex, not converging posteriorly, posterolateral corners broadly rounded; abdomen elongate.

| | mm. |
|---|---|
| Length of body | 10.00 |
| Width of head | 2.00 |
| Width of pronotum | 2.06 |

LUZON, Laguna Province, Paete, March 7, 1917; inhabiting an old palm stub.

## COPTOTERMITINÆ

### Genus **COPTOTERMES** Silvestri

**Coptotermes travians** (Haviland).

*Termes travians* HAVILAND, Journ. Linn. Soc. London 26 (1898) 391, pl. 23, figs. 19–22 (Singapore and Sarawak).

PANAY, Antique Province, Culasi, July 1, 1918; inhabiting a house-post and clothing. LUZON, Manila, Malate, May 20, 1917; from the inside of posts and floors of Mr. McGregor's house. On November 29, 1917, a vast number of nymphs, soldiers, and workers were also collected in the building of the Bureau of Science, at Malate, attacking a mass of papers.

**Coptotermes formosanus** Shiraki.

*Coptotermes formosanus* SHIRAKI, Trans. Ent. Soc. Japan 2 (1909) 239 (Formosa).

*Soldier.*—Head and labrum deep yellow, tip of labrum hyaline; antennæ somewhat paler; mandibles reddish brown; pronotum yellow; abdomen and legs straw-colored. Head and thorax sparingly pilose; abdominal tergites densely covered with short, spiny hairs.

Head suborbicular, somewhat elongate, sides slightly converging anteriorly; fontanelle distinct, orifice directed forward; clypeus trapezoidal, very short, distinction between anteclypeus and postclypeus obscure; labrum lancet-shaped, with a sharply pointed tip, reaching middle of mandibles; mandibles slender, saber-shaped, with incurved piercing tip, cutting edge smooth;

antennæ 15-jointed, basal joint cylindrical, second joint quadrate, longer than third, third joint the smallest, nearly half as long as fourth, fifth to fourteenth joints suborbicular, apical joint oval; pronotum subreniform, narrower than head, anterior and posterior borders bilobed, lateral borders rounded, converging posteriorly; mesonotum and metanotum oval, the former slightly narrower than pronotum while the latter is much broader.

| | mm. |
|---|---|
| Length of body | 4.80–5.50 |
| Length of head, with mandibles | 2.19–2.28 |
| Length of head, without mandibles | 1.41–1.44 |
| Width of head | 1.15–1.21 |
| Width of pronotum | 0.81–0.87 |
| Length of pronotum | 0.47 |

*Worker.*—Head, thorax, and abdomen milk-white, densely pilose.

Head spherical; antennæ 15-jointed, second joint longer than third, third joint ring-shaped, fourth joint a little shorter than second; clypeus more or less swollen; pronotum much narrower than head, semilunar, anterior border obscurely bilobed.

| | mm. |
|---|---|
| Length of body | 4.00 |
| Width of head | 1.19 |
| Width of pronotum | 0.85 |

LUZON, Manila, February 17, 1917.

*Remarks.*—The present species is the most serious pest to wooden structures and woodwork in Formosa. It is here recorded for the first time from the Philippine Islands.

## RHINOTERMITINÆ

### Genus RHINOTERMES Hagen

**Rhinotermes (Schedorhinotermes) tarakensis** Oshima. Plate 3, figs. 7 and 8; Plate 4, figs. 6 and 7.

*Rhinotermes (Schedorhinotermes) tarakensis* OSHIMA, Annot. Zool. Jap. 8 (1914) 564, pl. 10, fig. 2 (Tarakan, Dutch Borneo).

*Imago.*—Unknown.

*Soldier (the larger form).*—Head deeply yellow, labrum, antennæ, and labial palpi paler; mandibles light reddish brown; thorax, abdomen, and legs yellow. Head and thorax very sparingly pilose; abdominal tergites moderately covered with delicate hairs and spiny hairs.

Head suborbicular, sides very slightly converging anteriorly, posterior border broadly rounded; fontanelle distinct, directed obliquely forward; a shallow longitudinal groove from fontanelle to tip of labrum; anteclypeus whitish, anterior border rounded; postclypeus trapezoidal, nearly as long as the former; labrum tongue-shaped, scarcely reaching tip of mandibles, tip hyaline, anterior border obscurely bilobed, densely provided with short hairs; antennæ 15-jointed, first joint cylindrical, second joint slightly shorter than third, quadrate, fourth joint orbicular, nearly as long as third, other joints spherical, subequal in length, apical joint oval; mandibles rather short, with strongly incurved, piercing tip, the left with two sharply pointed teeth, subequal in size, the right with one strong tooth, acutely pointed; pronotum much narrower than head, inverted-heart-shaped, anterior border convex, posterior border weakly incurved at middle, sides rounded; mesonotum slightly narrower than pronotum; metanotum as broad as pronotum, ovoid, much shorter than mesonotum; abdomen rather short; styli one-jointed; hind legs reaching beyond the tip of abdomen.

| | mm. |
|---|---|
| Length of body | 3.50 |
| Length of head, with mandibles | 1.81–2.00 |
| Length of head, without mandibles | 1.18–1.28 |
| Width of head | 1.21–1.28 |
| Width of pronotum | 0.64–0.70 |
| Length of pronotum | 0.43–0.46 |

*Soldier (the smaller form).*—

| | mm. |
|---|---|
| Length of body | 3.00 |
| Length of head, with mandibles | 1.25 |
| Length of head, without mandibles | 0.69–0.75 |
| Width of head | 0.69–0.72 |
| Width of pronotum | 0.43–0.46 |
| Length of pronotum | 0.31–0.34 |

*Worker.*—

| | mm. |
|---|---|
| Length of body | 3.50–4.20 |
| Width of head | 1.18–1.25 |
| Width of pronotum | 0.53–0.56 |

LUZON, Laguna Province, San Antonio near Paete, March 12, 1917; discovered under a hard, round, black nest.

*Remarks.*—There is no previous record of the occurrence of the present species in the Philippine Islands, and the larger form of soldier is here described for the first time.

**Rhinotermes (Schedorhinotermes) longirostris** (Brauer).

*Termes longirostris* BRAUER, Reise Novara, Neur (1865) 47 (Iles Nicobar).

LUZON, Laguna Province, Paete, March 6, 1917; a vast number of soldiers (both forms) and workers.

*Remarks.*—Tunnels in a much decayed log.

**Rhinotermes (Schedorhinotermes) bidentatus** sp. nov. Plate 2, figs. 1 and 2; Plate 3, figs. 9, 10, 13, 14.

*Imago.*—Unknown.

*Soldier (the larger form).*—Head dark yellow; antennæ, labial palpi, and labrum somewhat paler; anteclypeus whitish; mandibles reddish brown; pronotum and abdomen yellow. Head and sternites very sparingly provided with spiny hairs; abdominal tergites with a series of delicate hairs along the posterior border, a few scattered spiny hairs.

Head quadrate, sides slightly converging anteriorly, posterior border broadly rounded; fontanelle distinct, directed obliquely forward, situated between roots of antennæ; a shallow groove from fontanelle to tip of labrum, slightly widened anteriorly; clypeus nearly half as long as broad, anterior border rounded, boundary between anteclypeus and postclypeus indistinct; labrum tongue-shaped, anterior border straight, middle part of lateral border swollen; antennæ 16-jointed, basal joint cylindrical, second joint much shorter than third, fourth joint slightly shorter than second, nearly half as long as third, other joints spherical, subequal in length; mandibles rather short, with strongly incurved, piercing tip, the left with two triangular teeth, second tooth much smaller than the other, the right with two sharply pointed subequal teeth directed forward; pronotum narrower than head, subreniform, anterior border convex, posterior border slightly incurved at middle, sides converging posteriorly; mesonotum a little narrower than pronotum; metanotum nearly as broad as mesonotum, posterior border straight; abdomen ovoid; styli 2-jointed; hind legs reaching beyond tip of abdomen.

| | mm. |
|---|---|
| Length of body | 6.00–7.00 |
| Length of head, with mandibles | 3.00 |
| Length of head, without mandibles | 2.00 |
| Width of head | 1.86–1.93 |
| Width of pronotum | 1.26–1.33 |
| Length of pronotum | 0.67 |

*Soldier (the smaller form).*—Head dark yellow, antennæ, labrum, and clypeus somewhat paler; anteclypeus whitish; mandibles yellowish brown; thorax, abdomen, and legs yellow. Head, thorax, and abdominal tergites very sparingly provided with spiny hairs.

Head suborbicular, posterior border broadly rounded; fontanelle distinct, directed obliquely forward; a shallow longitudinal groove from fontanelle to tip of labrum, gradually widening anteriorly; clypeus semilunar, anterior margin rounded, anteclypeus obscurely separated from postclypeus; labrum elongate, extending beyond tip of mandibles, sides nearly parallel, tip distinctly bilobed, anterior margin of each lobe provided with a cluster of short, thick hairs; antennæ 16-jointed, basal joint cylindrical, rather short, second joint quadrate, nearly as long as third, fourth joint the shortest, more than half as long as third, fifth to fifteenth joints spherical, apical joint oval; mandibles slender, with sharply pointed, incurved tip, the left with two acutely pointed teeth, directed forward, second tooth smaller, the right with one tooth, sharply pointed; pronotum narrower than head, anterior border convex, posterior border weakly curved at middle, sides converging posteriorly; mesonotum oval, nearly as broad as pronotum; metanotum slightly broader than mesonotum; abdomen slender, hind legs exceeding its tip.

| | mm. |
|---|---|
| Length of body | 4.80–5.20 |
| Length of head, with mandibles | 1.87 |
| Length of head, without mandibles | 1.09 |
| Width of head | 1.00 |
| Width of pronotum | 0.81 |
| Length of pronotum | 0.50 |

*Worker.*—Head pale yellow; thorax and abdomen whitish; anterolateral corners of forehead brown. Head, thorax, and abdominal tergites moderately pilose.

Head quadrate, posterior border broadly rounded; clypeus swollen; antennæ 17-jointed, third joint smallest, half as long as second, fourth and fifth joints subequal; pronotum much narrower than head, more than twice as broad as long, anterior border raised, not bilobed, sides converging posteriorly, posterior border nearly straight, anterolateral corners acutely rounded; abdomen ovoid.

| | mm. |
|---|---|
| Length of body | 4.20–5.50 |
| Width of head | 1.40 |
| Width of pronotum | 0.75 |

PANAY, Antique Province, Culasi, May 18, 1918.

*Remarks.*—In a decayed log in forest.

## TERMITOGETONINÆ

### Genus **TERMITOGETONELLA** novum

Type of genus, *Termitogetonella tibiaoensis* sp. nov.

**Termitogetonella tibiaoensis** sp. nov. Plate 1, fig. 3; Plate 3, figs. 3 to 6; Plate 4, figs. 2 to 5.

*Imago.*—Head chestnut brown; postclypeus and antennæ yellowish; anteclypeus whitish; pronotum and abdomen yellowish brown. Head and thorax sparingly pilose, beset with a few spiny hairs; abdominal tergite with two series of spiny hairs along its posterior border, the anterior series composed of much longer hairs.

Head round; fontanelle small, distinct; postclypeus swollen, more than twice as long as anteclypeus; anteclypeus trapezoidal, very short, anterior border straight; labrum tongue-shaped; antennæ 17-jointed, basal joint cylindrical, second joint quadrilateral, much longer than third, fourth joint shorter than third, other joints spherical, subequal in size, apical joint oval; eye moderate, prominent; ocellus oval, approximated to eye; pronotum subreniform, anterior border obscurely bilobed, posterior border nearly straight, sides broadly rounded; mesonotum and metanotum subequal, narrower than pronotum; anterior wing stumps much larger than posterior, covering basal half of the latter; wings hyaline, costal and radius yellowish brown; radius of anterior wing near and parallel to costal, with no branch, median nerve originates from cubitus at the point of basal one-third, connected with the radius by irregular vertical nerves, cubitus runs above the middle of wing, giving off about fifteen branches, most of them connected with each other by short nerves; median nerve of posterior wing originates from radius, running nearer to cubitus than to radius; styli 1-jointed, slender.

| | mm. |
|---|---|
| Length of body, with wings | 11.00 |
| Length of body, without wings | 6.50 |
| Length of head | 1.25 |
| Width of head | 1.38 |
| Width of pronotum | 1.44 |
| Length of pronotum | 0.94 |
| Length of anterior wing | 8.50 |

*Soldier.*—Head brownish yellow, antennæ and labial palpi paler; mandibles reddish brown, darker anteriorly; pronotum yellow; abdomen and legs straw-colored. Head very coarsely covered with spiny hairs; thorax and abdominal tergites moderately pilose, the latter with a series of spiny hairs along the posterior border.

Head oval; fontanelle obscure; clypeus trapezoidal, indistinctly separated from forehead, not divided into two parts, anterior border straight; labrum tongue-shaped, obtusely pointed anteriorly, tip not reaching the middle of mandibles, provided with a few spiny hairs; mandibles saber-shaped, with incurved and upcurved piercing tip, the left with a sharply pointed tooth at middle of cutting margin, the right nearly smooth with a very low weak tooth; antennæ 17-jointed, basal joint enlarged, cylindrical, second joint elongate, nearly twice as long as third which is the smallest, fourth joint slightly longer than third, subequal to fifth, other joints quadrate, apical one oval; pronotum saddle-shaped, much narrower than head, anterior border bilobed, posterior border weakly incurved at middle, sides strongly converging posteriorly; mesonotum subreniform, narrower than pronotum; metanotum oval, nearly as broad as pronotum; abdomen rather short; styli 1-jointed, hind legs reaching beyond tip of abdomen.

| | mm. |
|---|---|
| Length of body | 5.50–7.00 |
| Length of head, with mandibles | 3.13–3.24 |
| Length of head, without mandibles | 2.08–2.25 |
| Width of head | 1.59–1.77 |
| Width of pronotum | 1.15–1.29 |
| Length of pronotum | 0.69–0.72 |

*Worker.*—Head yellow, antennæ and postclypeus somewhat paler; anteclypeus whitish; thorax and abdomen yellowish white. Head nearly smooth, with a few short spiny hairs; thorax and abdomen sparingly pilose.

Head quadrate, shorter than broad, posterior border broadly rounded; postclypeus swollen, trapezoidal; anteclypeus much narrower and shorter than the former, anterior border straight; antennæ 13-jointed, second joint nearly as long as third, fourth joint narrow, half as long as third; pronotum semilunar, anterior and posterior borders straight, sides converging posteriorly.

| | mm. |
|---|---|
| Length of body | 4.20–5.00 |
| Width of head | 1.15–1.44 |
| Width of pronotum | 0.94–1.19 |

PANAY, Antique Province, Tibiao, May 9, 1918; Culasi, May 16, 1918.

*Remarks.*—Found in an old log.

## METATERMITIDÆ

**Termes (Macrotermes) philippinensis** Oshima.

> *Termes* (*Macrotermes*) *philippinensis* OSHIMA, Annot. Zool. Jap. 8 (1914) 566 (Los Baños).

*Locality.*—LUZON, Manila, Malate, 1918 (*W. H. Brown*); San Juan del Monte, June 10, 1917: Bulacan Province, Polo, May 30, 1917: Laguna Province, Paete, March 6, 1917; Pañgil, March 25, 1917 (*McGregor*). PANAY, Antique Province, Culasi, May 26, 1918 (*McGregor*).

*Remarks.*—The present species builds a large earth mound on the ground, connected with the subterranean nest. Winged forms swarm at the end of June. The specimens from Malate, Manila, were taken from the mound figured by Brown.[1]

**Termes (Macrotermes) luzonensis** Oshima.

> *Termes* (*Macrotermes*) *luzonensis* Oshima, Annot. Zool. Jap. 8 (1914) 569, pl. 9, figs. 10 and 11 (Los Baños).

LUZON, Laguna Province, Pañgil, a large queen, collected on March 25, 1917; Paete, March 10, 1917: San Francisco del Monte near Manila, June 14, 1917.

*Remarks.*—This species builds a large earth mound. Mr. McGregor found its tunnels on *Artocarpus integrifolia.*

**Termes (Macrotermes) manilanus** Oshima.

> *Termes* (*Macrotermes*) *manilanus* OSHIMA, Annot. Zool. Jap. 8 (1914) 565 (Manila).

Soldiers and workers are still unknown.

PANAY, Antique Province, Lipata near Culasi, July 31, 1918, at night at a lighted lantern on the beach. LUZON, Manila, June 5, 1917.

**Termes (Macrotermes) copelandi** Oshima.

> *Termes* (*Macrotermes*) *copelandi* OSHIMA, Annot. Zool. Jap. 8 (1914) 570, pl. 9, figs. 6 and 7 (Los Baños).

LUZON, Manila, Santa Mesa, Calle Buena Vista, May 27, 1917; San Francisco del Monte, January 14 and February 22, 1917; San Juan del Monte, June 10, 1917; Montalban, February 22, 1918; Antipolo, November 11, 1917. PANAY, Capiz Province, Ibajay, August 9, 1918.

*Remarks.*—*Termes copelandi* is a species which builds large clay mounds on the ground. Its earthen runways are often found on bamboo fences and on shrubs. According to Mr. Mc-

[1] Philip. Journ. Sci. 13 (1918) Bot. pl. 3.

Gregor's information, it attacks *Eugenia jambolana* and *Leucaena glauca,* making large tunnels on their twigs.

### Genus ODONTOTERMES Holmgren

**Odontotermes mediodentatus** sp. nov. Plate 1, fig. 4; Plate 3, figs. 11 and 12; Plate 4, figs. 8 and 9.

*Imago.*—Unknown.

*Soldier.*—Head reddish yellow; antennæ and labial palpi yellow; mandibles dark reddish brown, proximal parts much paler; thorax, abdomen, and legs yellowish. Head sparingly pilose; thorax and abdominal tergites moderately covered with hairs, the latter with a series of short spiny hairs along the posterior borders.

Head ovoid, sides very slightly converging anteriorly, posterior border rounded; no fontanelle; clypeus quadrilateral, not divided into two parts, posteriorly not separated from forehead, anterior border straight; labrum rather short, tongue-shaped, tip obtusely pointed, not reaching middle of mandibles, with no hyaline portion; mandibles rather slender, with incurved piercing tip, the left with two triangular teeth, one at the center, the other at the proximal part, cutting margin of the right smooth; antennæ 16-jointed, first joint cylindrical, exceedingly large, second joint longer than broad, nearly twice as long as third, fourth joint slightly longer than third, fifth joint subequal to third, other joints inverted-cone-shaped, apical joint oval; pronotum saddle-shaped, narrower than head, anterior border entire, posterior border weakly incurved at middle; mesonotum slightly narrower than pronotum, posterior border bilobed; metanotum broader than pronotum, posterior border straight; abdomen rather short; styli 1-jointed.

| | mm. |
|---|---|
| Length of body | 5.00–6.00 |
| Length of head, with mandibles | 2.56–2.71 |
| Length of head, without mandibles | 1.65–1.87 |
| Width of head | 1.38–1.50 |
| Width of pronotum | 0.97–1.03 |
| Length of pronotum | 0.59–0.63 |

*Worker.*—Head yellow, antennæ and labial palpi somewhat paler; thorax and abdomen yellowish white. Head densely covered with delicate hairs; thorax and abdominal tergites moderately pilose.

Head orbicular, posterior border rounded, sides very slightly diverging anteriorly; Y-suture not present; postclypeus swollen, anterior border of anteclypeus broadly rounded; antennæ 17-jointed, first joint elongate, cylindrical, second joint more than twice as long as third which is the smallest, fourth joint shorter than second; pronotum saddle-shaped, much narrower than head, anterior border entire.

| | mm. |
|---|---|
| Length of body | 3.50–4.00 |
| Width of head | 1.35 |
| Width of pronotum | 0.69 |

LUZON, Laguna, Paete, March 6, 1917.

*Remarks.*—The present species is very closely related to *Odontotermes denticulatus,* from Singapore. It differs from the latter in having the head and thorax a little larger in the case of the soldier.

## Genus **EUTERMES** Müller

**Eutermes (Hospitalitermes) hospitalis** (Haviland). Plate 3, fig. 19; Plate 4, fig. 12.

*Termes hospitalis* HAVILAND, Journ. Linn. Soc. London 26 (1898) 437, pl. 25, figs. 83–86 (Sarawak and Singapore).

*Soldier.*—Head, thorax, and abdomen dark castaneous, tip of rostrum somewhat paler; antennæ uniformly yellowish brown; coxa, trochanter, and femur isabelline, tibia and tarsus amber-colored. Head and thorax hairless; anterior border of pronotum provided with a series of short hairs; abdominal tergites sparingly beset with microscopic hairs.

Head pear-shaped, sides somewhat constricted in front; rostrum slender, its upper surface making a marked curve with that of head; antennæ 14-jointed, third joint more than twice as long as second, fourth joint slightly shorter than third, fifth to ninth joints elongate, subequal in length; other joints gradually decreasing in length, inverted-cone-shaped, apical joint oval; mandibles with slender, pointed apical portion; pronotum saddle-shaped, anterior border elevated, not bilobed; legs slender, exceedingly elongate.

| | mm. |
|---|---|
| Length of body | 4.50 |
| Length of head, with rostrum | 1.80–1.87 |
| Length of head, without rostum | 1.25 |
| Width of head | 1.15–1.18 |
| Width of pronotum | 0.66 |

*Worker (the larger form).*—Head dark castaneous, thorax and abdomen somewhat paler; anteclypeus and labrum brownish yellow; antennæ and labial palpi uniformly isabelline; coxa, trochanter, and femur yellowish brown, tibia and tarsus amber-colored. Head, thorax, and abdomen sparingly beset with microscopic hairs.

Head round, sides more or less converging anteriorly; Y-suture distinct, whitish; postclypeus swollen, its middle part depressed; anteclypeus short, with rounded anterior border; labrum tongue-shaped, antennæ 15-jointed, second joint much shorter than third, fourth joint shorter than third, but slightly longer than second, other joints elongate, subequal in length, apical joint oval, rather short; pronotum saddle-shaped, anterior border obscurely bilobed.

| | mm. |
|---|---|
| Length of body | 4.50–5.20 |
| Width of head | 1.12–1.15 |
| Width of pronotum | 0.75–0.78 |

*Worker (the smaller form).*—Color and hairiness as in the former; antennæ 15-jointed, second to fourth joints subequal in length.

| | mm. |
|---|---|
| Length of body | 3.80–4.20 |
| Width of head | 1.00 |
| Width of pronotum | 0.62 |

LUZON, San Francisco del Monte near Manila, January 14, 1917.

*Remarks.*—The present species distinctly differs from *Eutermes (H.) luzonensis* Oshima, which was formerly described under the name of *Eutermes (H.) hospitalis.*[2]

**Eutermes (Ceylonitermes) mcgregori** Oshima.

*Eutermes (Ceylonitermes) mcgregori* OSHIMA, Philip. Journ. Sci. § D 11 (1916) 361, pl. 1, fig. 19 (Sarai).

*Locality.*—PANAY, Antique Province, Tibiao; May 14, 1918, found in decayed wood.

**Eutermes (Eutermes) gracilis** Oshima.

*Eutermes (Eutermes) gracilis* OSHIMA, Philip. Journ. Sci. § D 11 (1916) 362, pl. 1, fig. 9, pl. 2, figs. 4 and 5 (Sarai).

*Locality.*—LUZON, Laguna Province, Paete, March 10, 1917.

*Remarks.*—Tunnels built by the present species were found on a palm, *Areca catechu.*

[2] Philip. Journ. Sci. § D 11 (1916) 360.

**Eutermes (Eutermes) balintauacensis** Oshima. Plate 3, fig. 17; Plate 4, fig. 16.

*Eutermes (Eutermes) balintauacensis* OSHIMA, Philip. Journ. Sci. § D 12 (1917) 224 (Balintauac).

*Locality.*—LUZON, Laguna Province, Paete, March 10, 1917, from old decayed wood.

**Eutermes (Eutermes) castaneus** sp. nov. Plate 2, fig. 4; Plate 3, fig. 18; Plate 4, fig. 15.

*Imago.*—Unknown.

*Soldier.*—Head brownish yellow, rostrum somewhat darker, antennæ dark yellow; thorax and abdomen pale chestnut-colored; labial palpi and legs straw-colored. Head and thorax sparingly provided with long spiny hairs; abdominal tergites densely pilose, long spiny hairs intermingled with minute ones.

Head broadly oval, sides strongly converging anteriorly, dorsal profile not straight, with a swelling at the junction of rostrum; rostrum rather long, slender, its upper surface on the same plane as that of the head; mandibles with more or less developed apical portion; antennæ 13-jointed, basal joint much enlarged, third joint elongate, nearly twice as long as fourth, second joint slightly longer than fourth, other joints inverted-cone-shaped, apical joint oval; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 3.00–3.20 |
| Length of head, with rostrum | 1.47–1.59 |
| Length of head, without rostrum | 0.81–0.84 |
| Width of head | 0.81–0.84 |
| Width of pronotum | 0.44–0.47 |

*Worker.*—Head yellow; antennæ and labial palpi much paler; thorax and abdomen yellowish white. Head, thorax, and abdominal tergites densely covered with short hairs.

Head quadrate, posterior border broadly rounded; Y-suture obscure; postclypeus more or less swollen, much shorter than half its width; anteclypeus longer than the former, obtusely pointed anteriorly; antennæ 14-jointed, second joint much longer than third, fourth joint the smallest, ring-shaped, nearly half as long as third; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 4.00–4.20 |
| Length of head | 1.09 |
| Width of pronotum | 0.59 |

LUZON, Laguna Province, Sarai near Paete, March 19, 1917. PANAY, Antique Province, Culasi, June 13, 1918.

*Remarks*.—The present species is very closely allied to *Eutermes gracilis*, from Sarai. The soldier of the latter has a wider head and a longer fourth antennal joint.

**Eutermes (Eutermes) las-piñasensis** sp. nov. Plate 2, fig. 3; Plate 4, fig. 13.

*Imago*.—Unknown.

*Soldier*.—Head yellowish brown; tip of rostrum reddish brown; pronotum brownish; antennæ, abdomen, and legs dark yellow. Head nearly smooth, with a few long spiny hairs; thorax smooth; abdominal tergites beset with miscroscopic hairs, posterior ones with a small number of long spiny hairs.

Head round, sides converging anteriorly, dorsal profile nearly straight, making a very weak curve; rostrum rather short, conical; mandible with a short, pointed apical portion; antennæ 13-jointed; second joint a little longer than fourth, third joint the longest, much longer than second; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 3.20–3.80 |
| Length of head, with rostrum | 1.59–1.62 |
| Length of head, without rostrum | 0.94–1.00 |
| Width of head | 0.94–1.00 |
| Width of pronotum | 0.47–0.50 |

*Worker*.—Head dark brown; anteclypeus yellowish; thorax and abdomen yellowish white; antennæ and legs dark yellow. Head moderately pilose; thorax nearly smooth, pronotum with a series of short hairs along the anterior border; abdominal tergites beset with minute hairs.

Head round, Y-suture distinct, whitish; postclypeus more or less swollen, much shorter than half the width; antennæ 14-jointed, third joint elongate, very slightly longer than second, fourth joint the smallest, nearly half as long as third; pronotum saddle-shaped, anterior border obscurely bilobed.

| | mm. |
|---|---|
| Length of body | 4.00 |
| Width of head | 1.19–1.22 |
| Width of pronotum | 0.59–0.69 |

LUZON, Paco, April 30, 1917: Rizal Province, Las Piñas, May 6 and 20, 1917: Laguna Province, Sarai, March 19, 1917: Bulacan Province, north of Polo, May 30, 1917.

*Remarks.*—Very closely allied to *Eutermes buitenzorgi* Holmgren, from Java. The soldier of the present species differs from that of the former in having a longer head.

A nest was found at the base of a small *Pithecolobium dulce*. It was actually observed that *Eutermes las-piñasensis* attacks *Barringtonia* and the above-mentioned tree, making wide-covered tunnels over the trunks.

**Eutermes (Trinervitermes) menadoensis** Oshima.

*Eutermes (Trinervitermes) menadoensis* OSHIMA, Annot. Zool. Jap. 8 (1914) 580, pl. 10, figs. 9 and 10 (Menado, Celebes).

LUZON, San Francisco del Monte, February 22, 1917; Masambuang, near Manila, February 22, 1917: Laguna Province, Paete, March 10, 1917.

*Remarks.*—The present species sometimes attacks *Ficus* and *Barringtonia*, making covered tunnels from nests in the ground.

**Eutermes (Rotunditermes) culasiensis** sp. nov. Plate 2, fig. 6; Plate 3, fig. 20; Plate 4, fig. 14.

*Imago.*—Unknown.

*Soldier.*—Head, antennæ, and labial palpi yellow; rostrum reddish brown, paler posteriorly; pronotum yellowish, with brownish anterior border; abdomen white; legs straw-colored. Head very sparingly beset with spiny hairs; thorax roughly pilose; abdominal tergites covered with minute hairs.

Head turnip-shaped, with a slender conical rostrum, dorsal profile nearly straight, making a curve; antennæ 12-jointed, second joint nearly as long as third, fourth joint slightly longer than third, other joints subequal in length; mandible with a short apical portion which is sharply pointed; pronotum saddle-shaped, anterior border entire, not bilobed.

| | mm. |
|---|---|
| Length of body | 3.20–3.80 |
| Length of head, with rostrum | 1.44–1.50 |
| Length of head, without rostrum | 0.85–0.94 |
| Width of head | 0.94–0.97 |
| Width of pronotum | 0.44–0.47 |

*Worker.*—Head yellow; antennæ, labial palpi, and thorax straw-colored; abdomen whitish. Head sparingly pilose; thorax and abdominal tergites moderately covered with minute hairs.

Head quadrate, posterior border broadly rounded; Y-suture distinct, whitish; postclypeus swollen, nearly twice as broad as long; anteclypeus short, obtusely pointed anteriorly; antennæ 13-jointed, second joint longer than fourth, third joint the smallest, shorter and narrower than fourth; pronotum saddle-shaped, anterior border distinctly bilobed.

| | mm. |
|---|---|
| Length of body | 4.20 |
| Width of head | 1.00 |
| Width of pronotum | 0.60 |

PANAY, Antique Province, Culasi, May 16, 1918, found in the bark of a decayed log.

**Eutermes (Grallatotermes) luzonicus** Oshima.

*Eutermes (Grallatotermes) luzonicus* OSHIMA, Annot. Zool. Jap. 8 (1914) 581, pl. 10, figs. 15 and 16 (Los Baños).

LUZON, San Juan del Monte near Manila, June 10, 1917: Rizal Province, Las Piñas, May 6, 1917: Laguna Province, Paete, March 4, 1917. PANAY, Antique Province, Tibiao, May 4, 1918: Capiz Province, Ibajay, August 9, 1918.

*Remarks.*—The present species attacks *Pithecolobium dulce, Spondias purpurea,* bamboos, and cocos. Very often it enters houses, attacking wooden parts.

**Eutermes (Grallatotermes) panayensis** sp. nov. Plate 2, fig. 5.

*Imago.*—Unknown.

*Soldier (the larger form).*—Head and abdominal tergites dark brown, thorax somewhat paler; rostrum reddish brown; antennæ and legs dark yellow. Head and thorax beset with a small number of long spiny hairs; abdominal tergites moderately covered with microscopic hairs, long spiny hairs intermingled with them.

Head round, dorsal profile weakly incurved at the junction of rostrum; rostrum rather short, cone-shaped; mandible with a short apical portion, sharply pointed; antennæ 13-jointed, second joint slightly longer than fourth, third joint the longest, much longer than second, other joints ovoid, elongate, subequal in length; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 4.50 |
| Length of head, with rostrum | 1.59–1.62 |
| Length of head, without rostrum | 1.03–1.06 |
| Width of head | 0.94–0.97 |
| Width of pronotum | 0.60 |

*Soldier (the smaller form).*—Head and rostrum uniformly reddish brown; thorax yellowish brown; abdominal tergites chestnut-colored; antennæ and legs yellow. Head and thorax with a small number of long, spiny hairs; abdominal tergites densely covered with microscopic hairs, with a series of long, spiny hairs along their posterior borders.

Head pear-shaped, sides converging anteriorly, dorsal profile nearly straight, with a weak swelling at the junction of rostrum; rostrum rather slender, conical; antennæ 13-jointed, second joint slightly longer than fourth, third joint the longest, much longer than second; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 3.00–3.80 |
| Length of head, with rostrum | 1.41–1.53 |
| Length of head, without rostrum | 0.88–0.94 |
| Width of head | 0.78–0.88 |
| Width of pronotum | 0.44 |

*Worker.*—Head and abdominal tergites dark brown; thorax yellowish brown; antennæ and legs dark yellow. Head pilose, long spiny hairs intermingled with microscopic ones; thorax nearly smooth, anterior border of pronotum provided with a series of short hairs; abdominal tergites moderately covered with minute hairs.

Head round, Y-suture distinct; forehead inclined anteriorly, postclypeus swollen, shorter than half the width; anteclypeus obtusely pointed anteriorly; antennæ 14-jointed, second nearly as long as third, fourth joint much shorter than third; pronotum saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 4.20–4.50 |
| Width of head | 1.06–1.09 |
| Width of pronotum | 0.60–0.66 |

PANAY, Antique Province, Culasi, July 16, 1918; tunnels on a large tree.

### Genus **CAPRITERMES** Wasmann

**Capritermes paetensis** sp. nov. Plate 2, figs. 7 and 8; Plate 3, figs. 15 and 16; Plate 4, figs. 10 and 11.

*Imago.*—Unknown.

*Soldier.*—Head brownish yellow, darker anteriorly, antennæ, labial palpi, and labrum somewhat paler; mandibles dark reddish brown, the left much darker; pronotum dark yellow, mesonotum and metanotum paler; abdomen and legs straw-colored. Head and thorax sparingly provided with spiny hairs; abdominal tergites with two transverse series of spiny hairs, interspace of which is roughly covered with minute hairs.

Head cylindrical, sides very slightly converging anteriorly, posterior border rounded; forehead abruptly inclined, more or less concave, with a shallow median groove; the vertical part of Y-suture deeply colored; fontanelle small; antennæ 14-jointed, basal joint cylindrical, exceedingly large, second joint quadrilateral, slightly shorter than third, fourth joint the shortest, much shorter than second, fifth to thirteenth joints elongate, club-shaped; anteclypeus quadrate, nearly as long as broad; postclypeus considerably shorter than the former, distinctly separated from forehead; labrum short, asymmetrical, much enlarged anteriorly, anterior border nearly straight, provided with a few long hairs, left anterolateral corner sharply pointed, the right obtusely rounded; mandibles asymmetrical, the right shorter and straighter, with an outcurved piercing tip, the left much bent, S-shaped, the basal third directed inward, the outer margin becoming gradually the upper, the middle third bending quickly outward, the apical third directed forward, the upper margin becoming again the outer, the tip obtusely pointed; gula elongate, narrow, much enlarged anteriorly, lateral borders concave; pronotum saddle-shaped, much narrower than head, anterior border rounded, posterior border obscurely bilobed; mesonotum narrower than pronotum, metanotum nearly as broad as pronotum; styli 1-jointed; hind legs slender, reaching beyond tip of abdomen.

| | mm. |
|---|---|
| Length of body | 5.50–6.00 |
| Length of head, with mandibles | 4.00–4.20 |
| Length of head, without mandibles | 2.20–2.30 |
| Width of head | 1.20 |
| Width of pronotum | 0.75–0.87 |

*Worker.*—Head yellow, antennæ somewhat paler; abdomen milk-white. Head sparingly pilose; abdominal tergites moderately covered with minute hairs.

Head spherical, Y-suture and fontanelle obscure; antennæ 14-jointed, second and third joints subequal in length, slightly shorter than fifth, fourth joint the smallest, nearly half as long as fifth; pronotum much narrower than head, saddle-shaped, anterior border rounded.

| | mm. |
|---|---|
| Length of body | 4.50 |
| Width of head | 1.00 |
| Width of pronotum | 0.56 |

LUZON, Laguna Province, Paete, March 10, 1917; in damp ground under vegetable waste.

*Remarks.*—The nearest relative of the present species is *Capritermes distinctus,* from Ceylon. The soldier of the latter is smaller and is provided with a broader pronotum and with shorter mandibles. Its worker is also smaller than that of *C. paetensis,* measuring 2.7 to 2.8 millimeters.

### Genus **MICROCEROTERMES** Wasmann

**Microcerotermes los-banosensis** Oshima.

> *Microcerotermes los-banosensis* OSHIMA, Annot. Zool. Jap. 8 (1914) 583, pl. 10, fig. 6 (Los Baños).

*Imago.*—Head and pronotum chestnut brown; clypeus, labrum, and antennæ yellowish brown; abdomen dark brown; legs dark yellow. Head moderately pilose, covered with delicate hairs and a small number of spiny hairs; pronotum and wing stumps beset with strong spiny hairs; mesonotum and metanotum covered with minute hairs; abdominal tergites densely covered with delicate hairs.

Head round, no fontanelle; anteclypeus whitish, much shorter than postclypeus, anterior border obtusely pointed; postclypeus swollen, nearly half as long as broad; labrum tongue-shaped, broader than long; eye moderate, slightly prominent; ocellus round, the distance from eye less than twice its diameter; antennæ 14-jointed, basal joint cylindrical, much enlarged, second joint quadrilateral, twice as long as third which is the smallest, fourth joint slightly shorter than second, other joints spherical, subequal in length, apical joint oval; pronotum narrower than head, subreniform, anterior border nearly straight, posterior border weakly indented at middle, sides converging posteriorly; mesonotum and metanotum subequal, longer than pronotum, their posterior borders strongly indented at the middle; anterior wing stumps larger than posterior, not covering the base of the latter; wings brownish, coarsely beset with short, spiny hairs; radius nerve of anterior wing nearly straight, not branched, running near and parallel to costal margin, median nerve nearer to cubitus than to radius, bifurcated at tip, cubitus with seven branches, not reaching tip of wing, its root united to that of median nerve, dental nerve distinct; median nerve of posterior wing originates from the proximal part of radius; cubitus with eight branches; styli short; hind legs not reaching tip of abdomen.

| | mm. |
|---|---|
| Length of body, with wings | 8.00–9.00 |
| Length of body, without wings | 4.50–5.00 |
| Length of head | 0.85–0.91 |
| Width of head | 0.78–0.81 |
| Width of pronotum | 0.66–0.72 |
| Length of pronotum | 0.38–0.44 |

*Ergatoid.*—Head and pronotum chestnut brown; antennæ yellowish brown; wing pads and abdominal tergites chestnut brown, somewhat paler than head; legs and integument of abdomen dark yellow. Head moderately covered with delicate hairs; pronotum and wing pads sparingly pilose, abdominal tergites densely beset with minute hairs.

Head round; no fontanelle; anteclypeus nearly half as long as postclypeus, anterior border obtusely pointed; postclypeus swollen, twice as broad as long; labrum tongue-shaped; eye more or less prominent; ocellus yellowish, round, the distance to the eye less than twice as long as its diameter; antennæ 14-jointed, basal joint cylindrical, elongate, second joint longer than fourth, third joint ring-shaped, half as long as fourth, fifth joint quadrate, other joints ovoid, subequal in length; pronotum slightly narrower than head, semilunar, anterior border nearly straight, posterior border obscurely bilobed, sides rounded, converging posteriorly; mesonotum slightly longer than pronotum, posterior border straight; metanotum as long as pronotum, with straight posterior border; wing pads well-developed, produced posteriorly, tip of the anterior pair reaching beyond posterior border of metanotum, posterior pair shorter than the anterior; abdomen enlarged, integument between abdominal tergites extended; styli rather short, 2-jointed.

| | mm. |
|---|---|
| Length of body | 6.00–10.00 |
| Length of head | 0.85 |
| Width of head | 0.85 |
| Width of pronotum | 0.75 |
| Length of pronotum | 0.47 |

*Soldier.*—

| | mm. |
|---|---|
| Length of body | 5.00–5.50 |
| Length of head, with mandibles | 2.44–2.66 |
| Length of head, without mandibles | 1.50–1.56 |
| Width of head | 1.00–1.03 |
| Width of pronotum | 0.63–0.69 |
| Length of pronotum | 0.32–0.35 |

*Worker.*—

| | mm. |
|---|---|
| Length of body | 4.00–4.50 |
| Width of head | 0.94–1.03 |
| Width of pronotum | 0.53–0.58 |

LUZON, Manila, Malate, December 31, 1916; San Francisco del Monte, February 22, 1917; Masambuang, January 14, 1917; Las Piñas, May 20, 1917; Guadalupe, January 6, 1917: Bulacan Province, Polo, May 31, 1917 (imagoes, soldiers, and workers): Laguna Province, San Antonio near Paete, March 13, 1917; Sarai near Paete, March 19, 1917. PANAY, Antique Province, Tibiao, May 9, 1918; Culasi, June 6, 1918; Batbatan Island, June 30, 1918. ROMBLON, August 13, 1918 (imagoes, soldiers, and workers).

*Remarks.*—The present species seems to be one of the commonest termites in the Philippine Islands. Occasionally it attacks *Pithecolobium dulce*, cocos, or bamboos, constructing small, hard nests at their bases or below the ground.

Among the individuals that were collected at Tibiao, on May 9, 1918, were sixteen grown-up ergatoids, together with a vast number of young larvæ and eggs.

# ILLUSTRATIONS

### Plate 1

FIG. 1. *Calotermes (N.) malatensis* Oshima, soldier.
2. *Calotermes (N.) lagunensis* sp. nov., soldier.
3. *Termitogetonella tibĭaoensis* g. et sp. nov., soldier.
4. *Odontotermes mediodentatus* sp. nov., soldier.

### Plate 2

FIG. 1. *Rhinotermes (Sch.) bidentatus* sp. nov., larger form of soldier.
2. *Rhinotermes (Sch.) bidentatus* sp. nov., smaller form of soldier.
3. *Eutermes (E.) las-piñasensis* sp. nov., soldier.
4. *Eutermes (E.) castaneus* sp. nov., soldier.
5. *Eutermes (G.) panayensis* sp. nov., soldier.
6. *Eutermes (R.) culasiensis* sp. nov., soldier.
7. *Capritermes paetensis* sp. nov., soldier.
8. *Capritermes paetensis* sp. nov., soldier's head.

### Plate 3

FIG. 1. *Calotermes (N.) lagunensis* sp. nov., soldier's left mandible.
2. *Calotermes (N.) lagunensis* sp. nov., soldier's right mandible.
3. *Termitogetonella tibiaoensis* g. et sp. nov., imago's anterior wing.
4. *Termitogetonella tibiaoensis* g. et sp. nov., imago's posterior wing.
5. *Termitogetonella tibiaoensis* g. et sp. nov., soldier's left mandible.
6. *Termitogetonella tibiaoensis* g. et sp. nov., soldier's right mandible.
7. *Rhinotermes (Sch.) tarakensis* Oshima, soldier's left mandible (larger form).
8. *Rhinotermes (Sch.) tarakensis* Oshima, soldier's right mandible (larger form).
9. *Rhinotermes (Sch.) bidentatus* sp. nov., soldier's left mandible (smaller form).
10. *Rhinotermes (Sch.) bidentatus* sp. nov., soldier's right mandible (smaller form).
11. *Odontotermes mediodentatus* sp. nov., soldier's left mandible.
12. *Odontotermes mediodentatus* sp. nov., soldier's right mandible.
13. *Rhinotermes (Sch.) bidentatus* sp. nov., soldier's left mandible.
14. *Rhinotermes (Sch.) bidentatus* sp. nov., soldier's right mandible.
15. *Capritermes paetensis* sp. nov., soldier's left mandible.
16. *Capritermes paetensis* sp. nov., soldier's right mandible.
17. *Eutermes (E.) balintauacensis* Oshima, soldier's mandible.
18. *Eutermes (E.) castaneus* sp. nov., soldier's mandible.
19. *Eutermes (H.) hospitalis* (Haviland), soldier's mandible.
20. *Eutermes (R.) culasiensis* sp. nov., soldier's mandible.

PLATE 4

FIG. 1. *Calotermes* (*N.*) *lagunensis* sp. nov., soldier's antenna.
2. *Termitogetonella tibiaoensis* g. et sp. nov., soldier's antenna.
3. *Termitogetonella tibiaoensis* g. et sp. nov., imago's left mandible.
4. *Termitogetonella tibiaoensis* g. et sp. nov., imago's right mandible.
5. *Termitogetonella tibiaoensis* g. et sp. nov., soldier's labrum.
6. *Rhinotermes* (*Sch.*) *tarakensis* Oshima, soldier's antenna (larger form).
7. *Rhinotermes* (*Sch.*) *tarakensis* Oshima, soldier's labrum and clypeus (larger form).
8. *Odontotermes mediodentatus* sp. nov., soldier's antenna.
9. *Odontotermes mediodentatus* sp. nov., soldier's labrum.
10. *Capritermes paetensis* sp. nov., soldier's antenna.
11. *Capritermes paetensis* sp. nov., soldier's labrum.
12. *Eutermes* (*H.*) *hospitalis* (Haviland), soldier's antenna.
13. *Eutermes* (*E.*) *las-piñasensis* sp. nov., soldier's antenna.
14. *Eutermes* (*R.*) *culasiensis* sp. nov., soldier's antenna.
15. *Eutermes* (*E.*) *castaneus* sp. nov., soldier's antenna.
16. *Eutermes* (*E.*) *balintauacensis* Oshima, soldier's antenna.

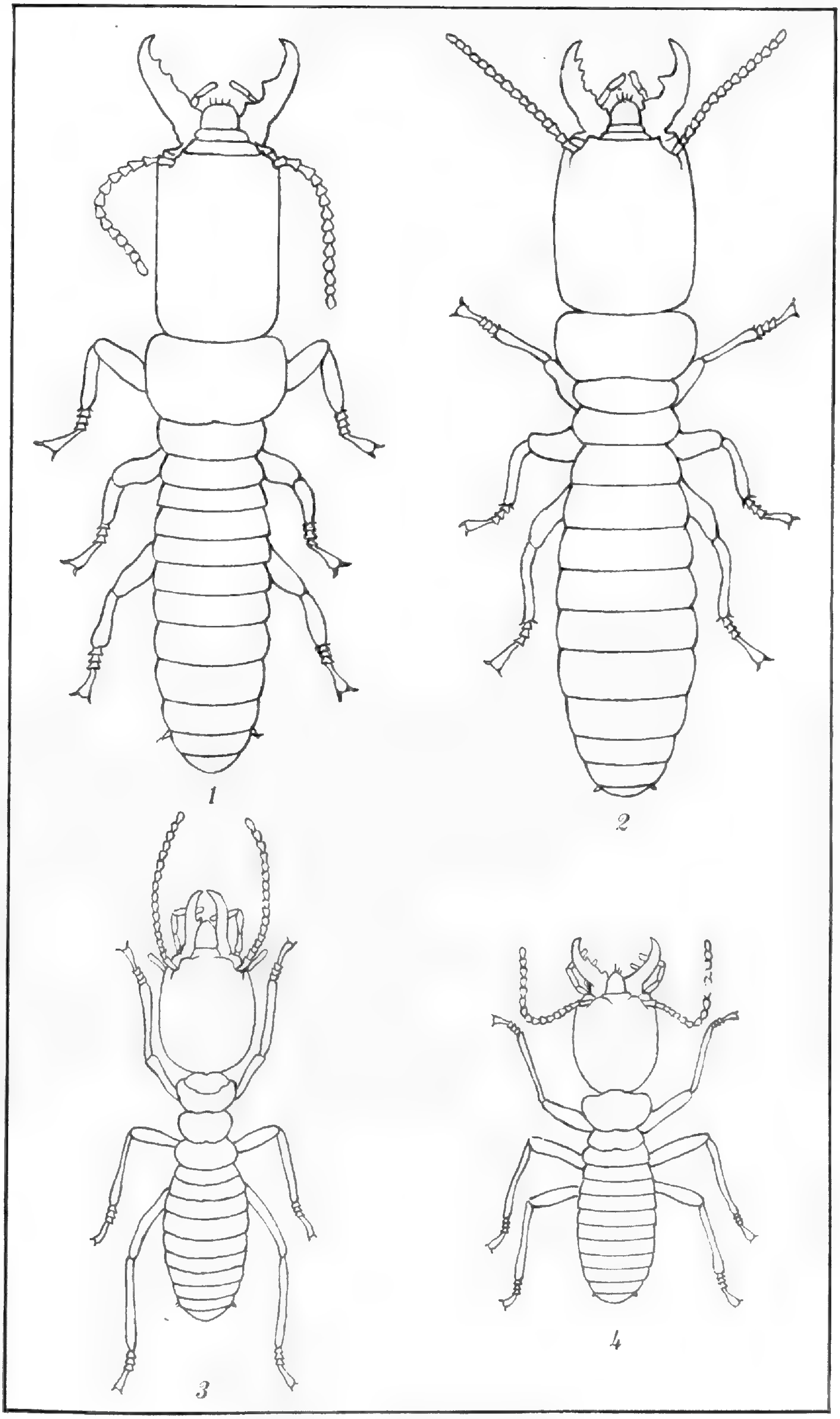


PLATE 1. PHILIPPINE TERMITES.

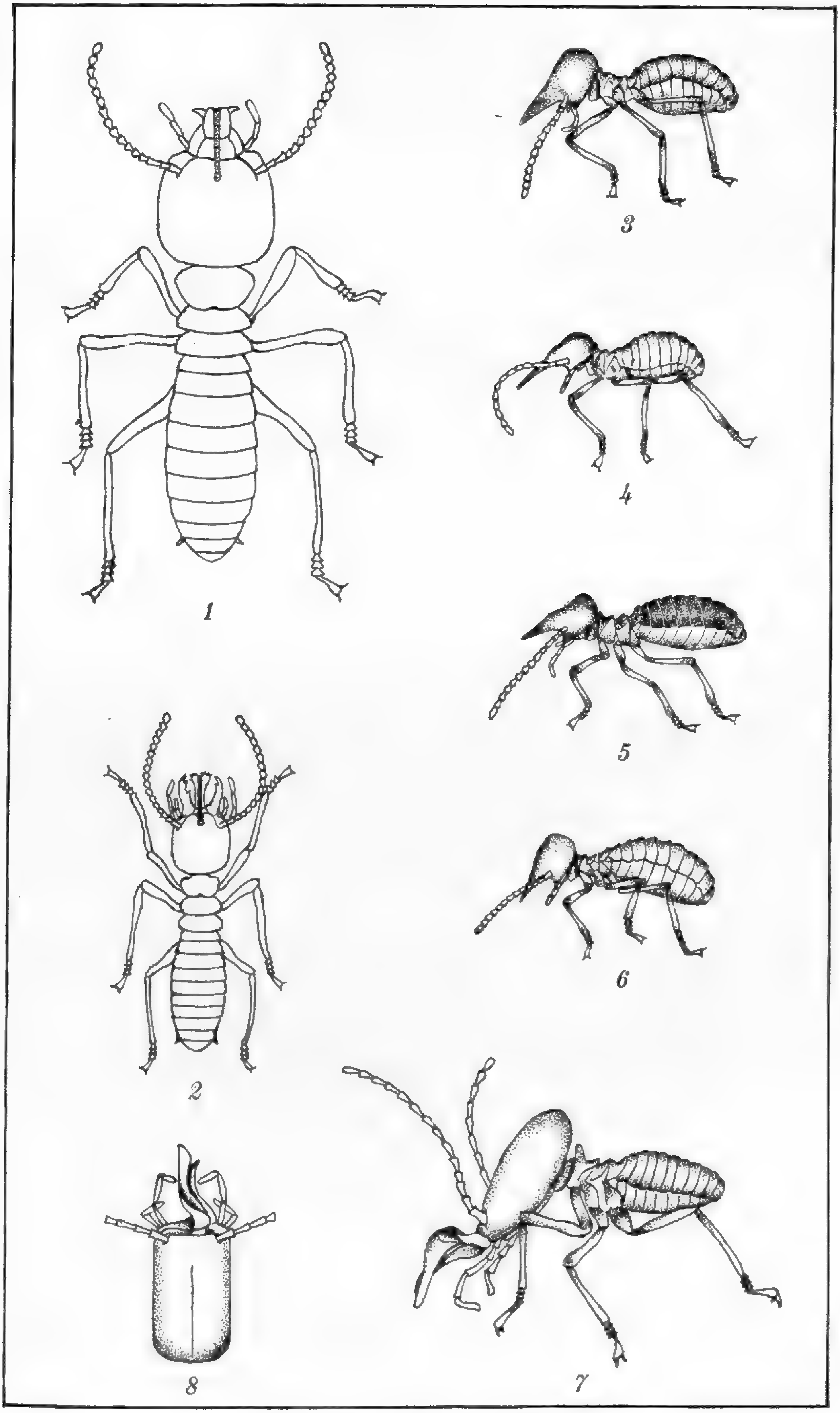


PLATE 2. PHILIPPINE TERMITES.

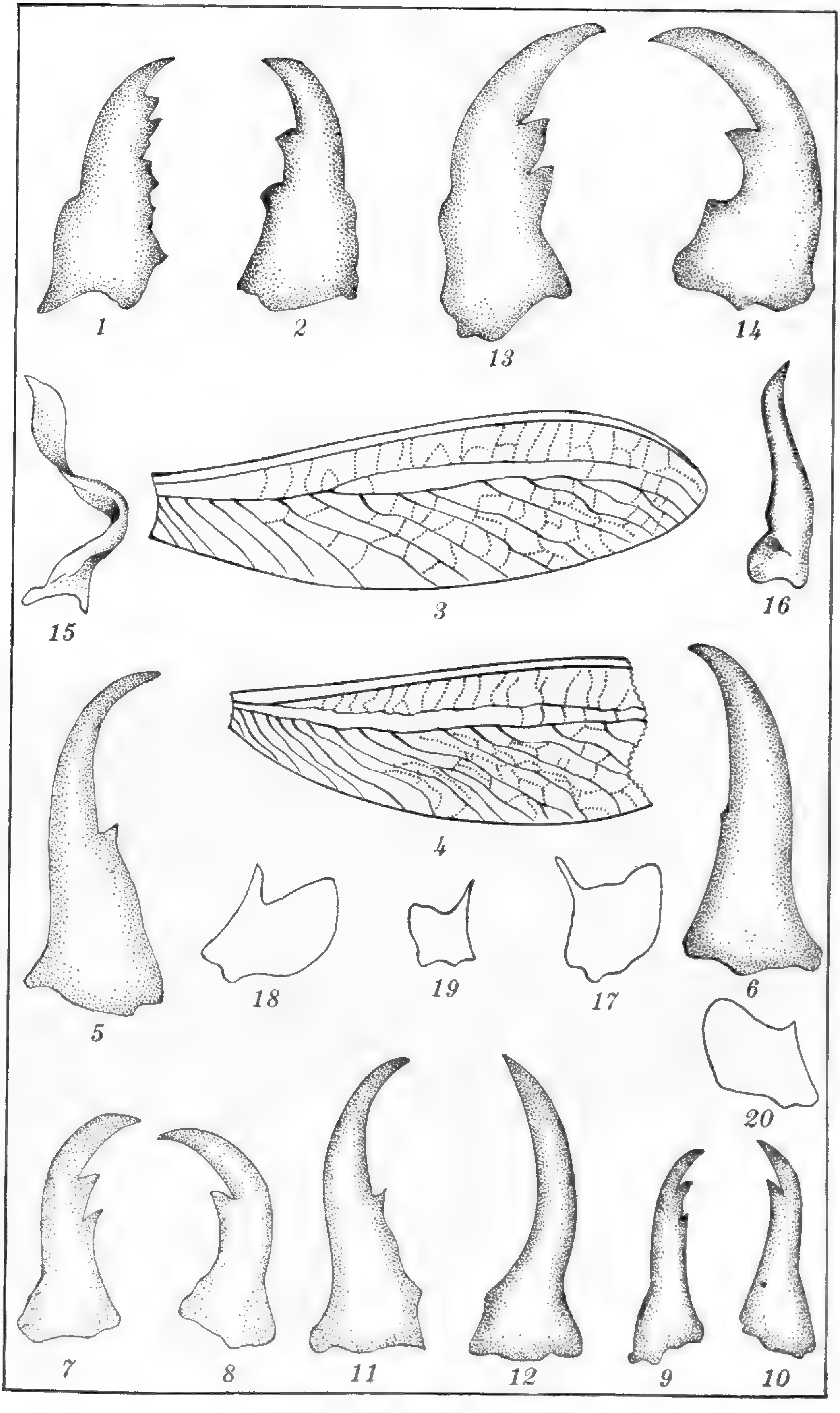


PLATE 3. PHILIPPINE TERMITES.

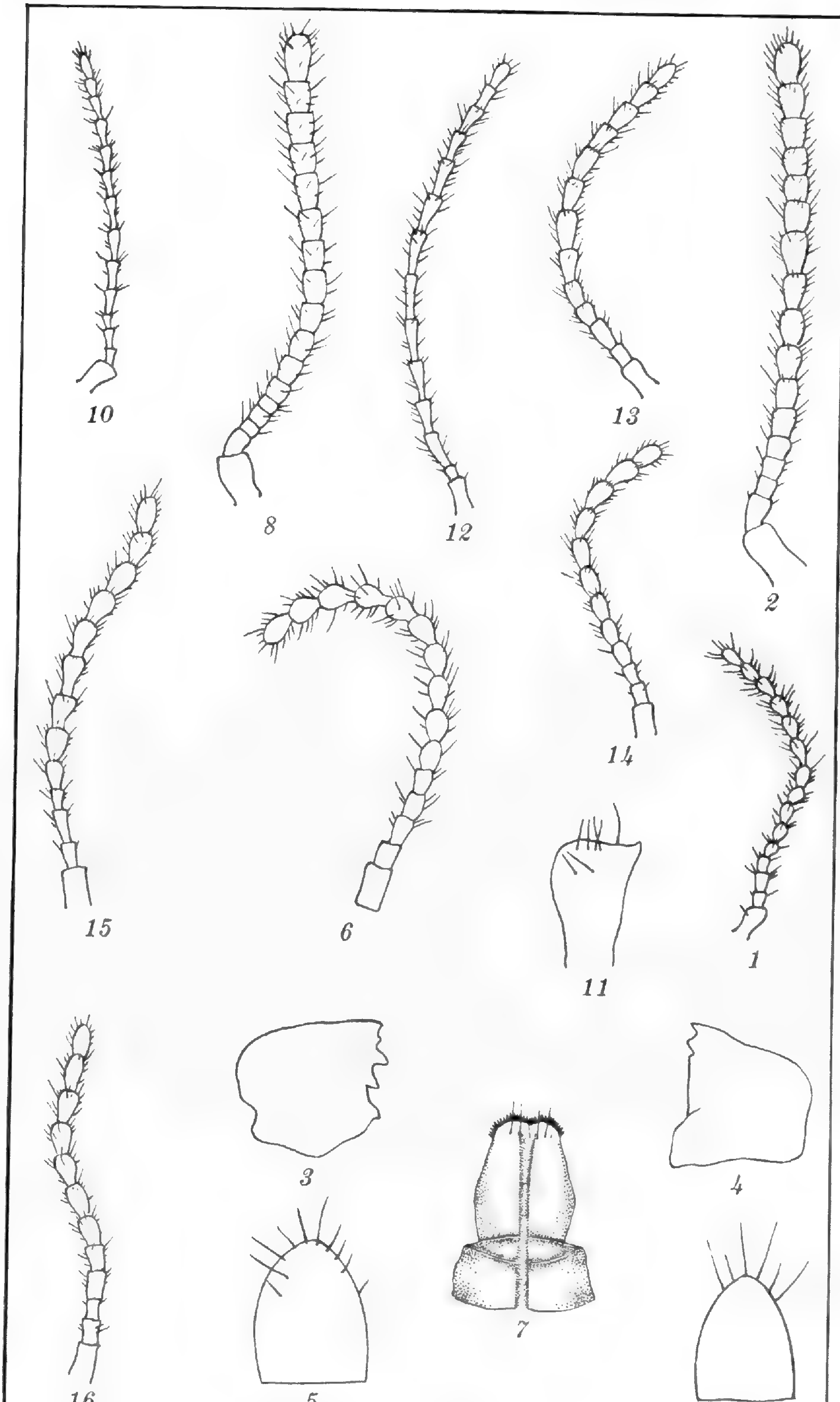


PLATE 4. PHILIPPINE TERMITES.

# THE OCCURRENCE IN THE PHILIPPINE ISLANDS OF THE FRESH-WATER AMPHIPOD PARACALLIOPE FLUVIATILIS (G. M. THOMSON)

By CHAS. CHILTON

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The amphipod *Paracalliope fluviatilis* was described in 1879 by G. M. Thomson, under the name *Calliope fluviatilis,* as occurring in fresh-water streams near Dunedin, New Zealand. Subsequently it was found to be common in fresh-water streams in all parts of New Zealand and to occur also in harbors, tidal estuaries, etc., where the water was brackish or at times quite salt. In 1899 Stebbing established the genus *Paracalliope* for this species and in 1906 [1] he referred to it the species that had been described by W. A. Haswell in 1880 as *Pherusa australis* from specimens obtained at Botany Bay. Though nothing was said about the exact circumstances under which these specimens were found, it is to be presumed that they were taken in salt waters. Although I have been unable to obtain specimens of *Pherusa australis* from Australia for comparison, I feel confident that Stebbing is right in considering that species as a synonym of *Paracalliope fluviatilis.*

Recently when examining the amphipods from Chilka Lake, India, I found numerous specimens of *Paracalliope fluviatilis* from different localities in the lake and others from Adyar River near Madras. Apparently it occurs on the shores of India under similar conditions to those in New Zealand. About a month after the manuscript of my report on the Chilka Lake amphipoda had been posted I received a few amphipoda from the Philippine Islands sent by Prof. C. F. Baker, and among them there were several specimens of *Paracalliope fluviatilis* from Nasugbu, "shallow water." Along with them was a single specimen of *Photis longicaudata* (Bate and Westw.), but there was no record as to whether the specimens were obtained in fresh water or in salt. The specimens both from Chilka Lake

[1] Das Tierreich, Amphipoda, p. 297.

and from the Philippine Islands agree very closely with those from New Zealand, and I can find no difference of specific importance.

As *Paracalliope fluviatilis* appears to be confined to fresh and brackish water near the coast, its wide distribution in India, Philippine Islands, and New Zealand will help to throw light on the changes in the land areas of these regions that must have occurred to account for its present distribution. In this connection it may be mentioned that *Paracorophium excavatum* (G. M. Thomson), another amphipod occurring in brackish and fresh waters of New Zealand, has recently been sent to me from brackish waters in Brisbane River, Queensland, Australia.

# NIPHARGUS PHILIPPENSIS, A NEW SPECIES OF AMPHIPOD FROM THE UNDERGROUND WATERS OF THE PHILIPPINE ISLANDS

By CHAS. CHILTON

*Professor of Biology, Canterbury College, New Zealand*

THREE PLATES

For the opportunity of examining the interesting amphipod described in this paper I am indebted to Prof. C. F. Baker, of the College of Agriculture, Los Baños, Philippine Islands. By a fortunate coincidence the specimens forwarded by Professor Baker arrived just at the time when I was examining a new species of *Niphargus* from Chilka Lake, India; for, though different in several characters, the Philippine species is evidently closely related to the one from Chilka Lake. Professor Baker says that there are many subterranean drainage streams in the Philippine Islands, and wells frequently tap such streams; but near Los Baños the geological formation is all volcanic, and the waters usually emerge hot. He had examined several wells for amphipods without success, but recently Mr. S. Lantican, one of the students in zoölogy, found a well with moving cool water in the bottom and from this obtained the amphipods that were submitted to me. So far as is known, this is the first discovery of underground Crustacea in the Philippine Archipelago. From the statements made below it will be seen that the species differs from the description of the genus *Niphargus* given by Stebbing (4) in one or two points, in which, however, it agrees with the Chilka Lake species. The majority of the other characters are, nevertheless, so close to those of European species of *Niphargus* that I prefer to leave the species in the meantime under that genus.

## NIPHARGUS PHILIPPENSIS sp. nov.

*Specific diagnosis.*—Body long and narrow, side plates 1 to 4 shallower than their respective segments. Pleon segments 1 to 3 with the posterolateral corners rounded and bearing short setules in slight indentations. Eyes wanting. First antenna nearly as long as the body; second joint about as long as the first, third about one-third as long as the second; flagellum of about thirty joints, rather stout; secondary appendage very small, of two minute joints, shorter than the first joint of the primary flagellum. Second antenna about as long as the peduncle of the upper; flagellum of about six joints, the first being much longer than the others. First gnathopod with basal joint broad, ischium rounded on posterior side and covered with minute setæ; carpus slightly longer and broader than the propod; palm transverse, slightly convex. Second gnathopod with carpus subtriangular, propod narrow, oval, palm very oblique, occupying more than half the posterior margin of the propod, nearly straight, defined by one or two stout setules. First and second peræopods with the basal joint broadened, oval, greatest breadth about half the length. Fifth peræopod with basal joint of moderate size, remaining joints slightly broadened. Third uropods, when fully developed, about three-fourths the length of body, peduncle elongated, outer branch elongated, of two very long joints, first somewhat longer than the second, inner branch very small. Telson cleft to the base, each lobe bearing a stout seta at about the middle of the lateral margin and another near the extremity, with a minute setule placed at the extremity nearer the median line. Length of body, about 8 millimeters. Color, whitish.

*Locality.*—"From a well at Los Baños, Luzon. Collected by S. Lantican."

In addition to the specific diagnosis given above, the following further details may be useful. In general shape of the body the species resembles *Niphargus chilkensis* and most of the other species of the genus, the body being long, slender, and with the side plates much shallower than their respective segments. The head is produced laterally between the bases of the upper and lower antennæ into a distinct, rounded lobe. The pleon segments are not much produced downward, the first less so than the second and third; their lower margins are convex, the postero-inferior angle being broadly rounded and provided with minute setules arising from small indentations or serrations. The dorsal surface of the body is free from hairs or setæ.

The branchiæ are regularly oval, thus differing in shape from those of *N. chilkensis*, which are broad at the base. The anterior pairs are apparently smaller than the posterior. The length of the body of one specimen mounted on a micro-slide is about 8 millimeters, that of the upper antennæ being about the same, and the third uropod when fully developed about 5.5 millimeters.

In the upper antennæ the first and second joints of the peduncle are of about equal length, the first pair bearing at the end a distinct setule on the lower margin, and a few finer setules at the end of the second joint. The third joint is about one-third the length of the first. The flagellum is greatly elongated, sometimes containing as many as thirty-six joints, as shown in Plate 1, fig. 1; in this specimen the antenna on the other side was shorter and contained only twenty-eight joints. The accessory appendage is minute, consisting of two very small joints, and is easily overlooked. It will be seen from this description that the first antenna differs considerably from that of *N. chilkensis* in which the second joint of the peduncle is greatly elongated and bears distinct tufts of setæ on the upper margin toward its extremity. In the second antenna the gland cone is distinct, the last two joints of the peduncle subequal in length, the flagellum consisting of six distinct joints, the first much longer than any of the others, being nearly as long as the rest of the flagellum. In *N. chilkensis* the joints of the flagellum are faced together.

The upper lip is regularly rounded and slightly more convex near the median line where it is covered in the usual manner by a fur of minute setæ.

In the mandible the first joint of the palp is rather elongated, about one-third that of the second which is somewhat curved and slightly broadened, the third joint is about as long as the second and bears toward the extremity a number of setæ fully as long as the joint itself and extending almost at right angles to it. The cutting edges are normal and do not call for special description; the spine row contains numerous plumose spines. There seems to be little difference between the right and left mandibles.

The lower lip is of the usual shape, the mandibular process on each side being well marked and with the extremity rounded; the inner lobes are distinct, but rather small.

The first maxilla has the inner lobe well developed, broad, its oblique apical margin bearing twelve or more plumose setules; the outer lobe is of the usual shape, bearing about nine denticulate setules; the palp appears to be the same on both sides and bears at the apex some stout setules and a few slender hairs.

The second maxilla has the two lobes of about equal size, the outer with apical setæ only, the inner bearing an oblique row of long setæ near the inner margin in addition to those along the margin itself which merge into the usual apical setæ.

The maxillipeds have the inner lobe reaching about halfway along the outer, its truncate extremity with three stout setules and many smaller setules and hairs. The outer lobe is short, not reaching so far as the end of the carpus, its inner margin bearing stout setules, none of which are developed into spine teeth. The propod is much narrowed at the base, the dactyl is long and slender, nearly as long as the propod. In addition to the ordinary long setæ numerous fine short setules are present on the dactyl and on the distal portion of the propod.

The first gnathopod has the side plate produced a little anteriorly, the angle being rounded, the basal joint is broad with tufts of setæ on the posterior margin. The ischium is produced on the inner side into a rounded lobe, the whole of which is covered by minute setæ. Probably this joint meets the corresponding one on the other side when the limbs are being used and forms a grasping or triturating organ accessory to the appendages of the mouth. The carpus is considerably longer than the propod, its inner surface being thickly covered with tufts of long setæ as shown in Plate 1, fig. 1; the propod has the palm transverse and slightly convex.

The second gnathopod is considerably larger than the first, and differs to a rather marked degree in the shape of the carpus and propod; the carpus is triangular, with the tufts of setæ on its posterior margin compressed closely together; the propod is much longer than the carpus, oval, narrowing distally, the palm is slightly sinuous or nearly straight and much longer than the remaining portion of the posterior margin; the finger is strong and somewhat broad toward the base, but in the specimens examined does not show the bulging on the inner margin that is found in *N. chilkensis*.

The first and second peræopods are subequal and similar in structure. The basal joint has the anterior margin produced and strongly convex so that the whole joint forms an oval, the greatest breadth being rather more than half the length; the posterior margin is somewhat serrate with long hairs arising from the shallow serrations; the merus, carpus, and propod are of about the same length and bear only a few setules, two on the posterior margin of the propod being stouter than the others; the finger is rather short, acutely pointed.

The third peræopod is about the same length as the first and second, the basal joint is oval but the posterior margin is not greatly produced; it bears a number of fine setæ in small indentations; the carpus and propod are subequal and shorter than the merus.

The fourth peræopod is similar in shape and structure to the third but is longer, being intermediate in length between the third and fifth peræopods.

The fifth peræopod is much longer than the third and fourth but similar as regards the shape of the basal joint; the carpus and propod, however, are considerably longer in proportion to the merus, all three joints being slightly widened, their margins bearing stout setules arising from slight serrations; the finger is small and acute.

The pleopods are all well developed, the branches in each being equal in length and many-jointed.

The first and second uropods extend backward to about the same point; in the first uropod the peduncle is much longer than the branches, and the outer branch is slightly shorter than the inner. The second uropod is similar but has the peduncle much shorter, and the difference in length between the two branches is slightly greater. The third uropod is greatly elongated appearing, however, to differ in length according to the development of the animal. In some specimens examined it is more than half the length of the body. The peduncle is long, being nearly three times as long as the telson; the outer branch consists of two greatly elongated joints which appear somewhat narrow in the side view of the animal but are flattened, the first joint being broader than the second and bearing stout setules in slight serrations along one margin, the other margin being almost free from setæ; the second joint has few setæ on its margins but a distinct tuft of long hairs at the extremity. The inner branch is very small, slightly broadened, and bears a few setules at the extremity.

The telson is cleft to the base, each half oval with a distinct spinule at about the middle of the outer margin, another of about the same size at the outer portion of the extremity with a minute setule nearer the median line.

The two species *Niphargus philippensis* and *N. chilkensis* agree in two points in which they differ somewhat markedly from the generic diagnosis of *Niphargus* as given by Stebbing, namely:

1. The inner lobe of the first maxilla is large and broad and bears many plumose setæ.

2. The second gnathopod is larger than the first, and differs considerably from it in shape.

In his generic diagnosis Stebbing(4) (p. 405) says: "Maxilla 1, inner plate with few (2 or 3) setæ" and "Gnathopods 1 and 2 similar." In *N. pulchellus* [Sayce(3) (p. 152)] from Australia the inner plate of the first maxilla is broad and with numerous setæ, but in that species the first and second gnathopods are similar and subequal. The gnathopods in *N. chilkensis* and *N. philippensis* present a rather striking resemblance to those of *Phreatogammarus propinquus* Chilton from New Zealand(2) (p. 84), and also resemble those of *Metacrangonyx longipes* Chevreux(1) (p. 27), found in the Balearic Isles, more than they do those of typical species of *Niphargus*. In *Phreatogammarus* and in *Metacrangonyx* the third uropods are, however, very different from those of *Niphargus*, being elongated with equal branches in *Phreatogammarus*, and very short with inner branch vestigial in *Metacrangonyx*. The third uropods are, however, subject to much modification in all subterranean species, and possibly the gnathopods are more trustworthy as evidence of relationship than the variable terminal uropods.

*Niphargus philippensis*, although resembling *N. chilkensis* in the first maxilla, the shape of the gnathopods and particularly in the setose character of the ischium of the first gnathopod, differs in the following points, most of which have already been mentioned, namely:

1. In the absence of eyes.

2. In the different shape and size of the branchiæ.

3. In the shape of the first antenna, especially in the second joint of the peduncle and the long thickened flagellum.

4. In antenna 2, the joints of the flagellum being distinct and not fused as in *N. chilkensis*.

5. In the broadened basal joints of peræopods 1 and 2.

6. In the basal joint of the fifth peræopod, which is normal and not greatly enlarged, while in *N. chilkensis* the basal joint may be very large and longer than all the succeeding ones. In *N. chilkensis*, too, the joints of the three posterior pairs of peræopods show a greater tendency to be broadened, the merus especially so.

7. In the third uropods, which are more elongated in *N. philippensis* and not quite so broad in proportion as *N. chilkensis*.

An examination of the different specimens of *Niphargus philippensis* shows that there is considerable variation in the length and thickness of the flagellum of the first antenna, the length and thickening of the joints of the fifth peræopod, and in the length of the third uropods. The special characters of these appendages appear to be attained only in adult specimens and possibly they are more marked in the males than in the females.

In *Niphargus chilkensis* the parts that are similarly subject to special development seem to be the peduncle of the first antenna, the propod and dactyl of the second gnathopod, and the fifth peræopod.

REFERENCES

1. CHEVREUX, E. Biospeologica—Amphipodes. Arch. Zool. Exp. et Gén. 42 (1909) 27–42, pls. 1, 2.
2. CHILTON, C. Some New Zealand Amphipoda belonging to the genus Phreatogammarus. Journ. Zool. Research 3 (1918) 81–86, with text figures.
3. SAYCE, O. A. Niphargus pulchellus, a new Victorian blind amphipod. Proc. Roy. Soc. Victoria 12 (1900) 152–159, pl. 15.
4. STEBBING, T. R. R. Amphipoda, 1 Gammaridea. Das Tierreich, Lieferung 21 (1906).

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# ILLUSTRATIONS

(All the figures refer to *Niphargus philippensis* sp. nov.)

PLATE 1

FIG. 1. Side view of whole animal.
2. Peduncle of first antenna.
3. Second antenna.
4. Upper lip.
5. Mandible, showing palp, etc.
6. Mandible, showing cutting edge, molar tubercle, etc.
7. Lower lip.
8. First maxilla.
9. Second maxilla.

PLATE 2

FIG. 10. Maxilliped; 10*a*, terminal joints of same.
11. First gnathopod.
12. Second gnathopod.
13. First peræopod.
14. Third peræopod.

PLATE 3

FIG. 15. Fifth peræopod.
16. First uropod.
17. Second uropod.
18. Third uropod.
19. Third uropod, basal joint and inner branch.
20. Telson.
21. Pleon and uropoda, side view.

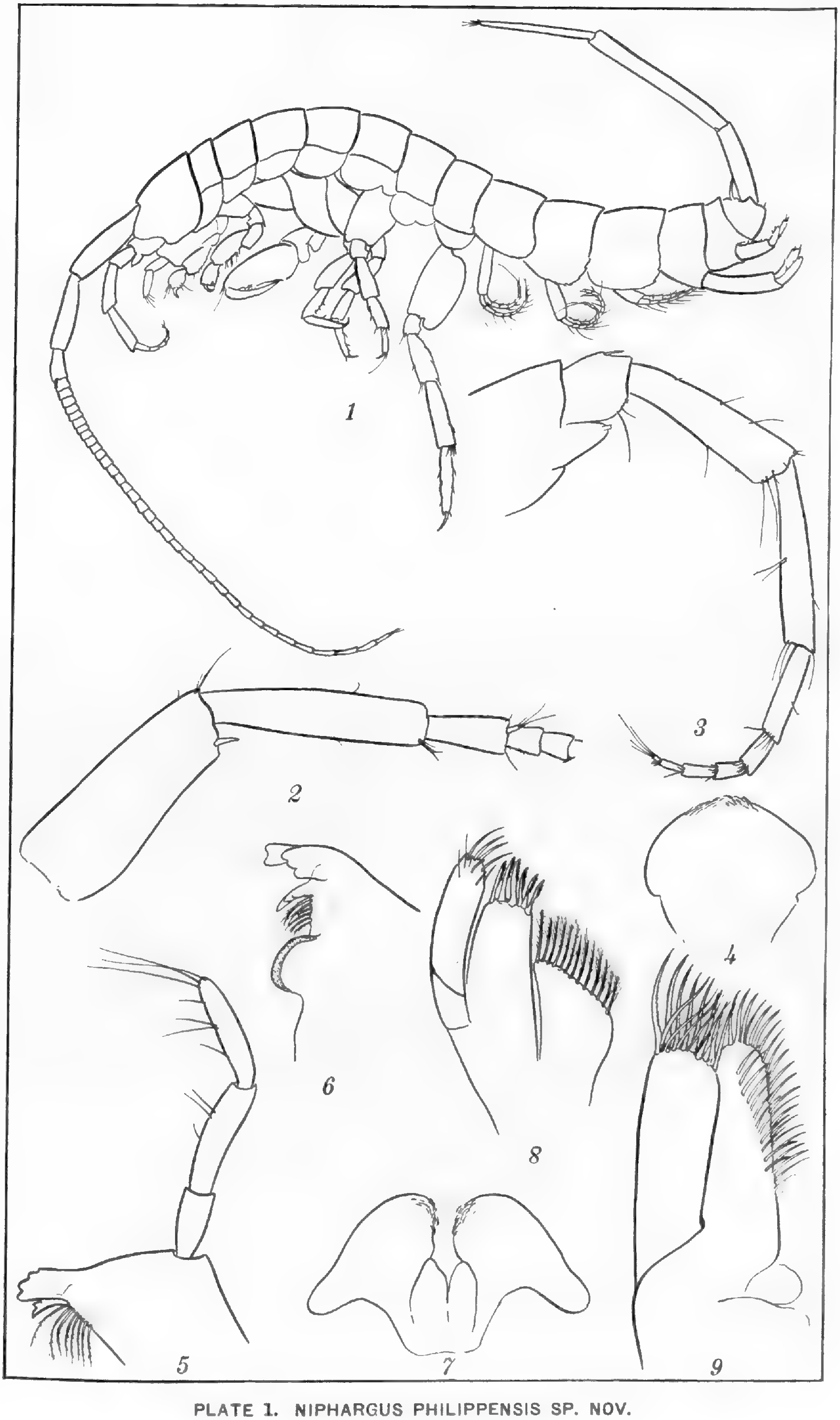


PLATE 1. NIPHARGUS PHILIPPENSIS SP. NOV.

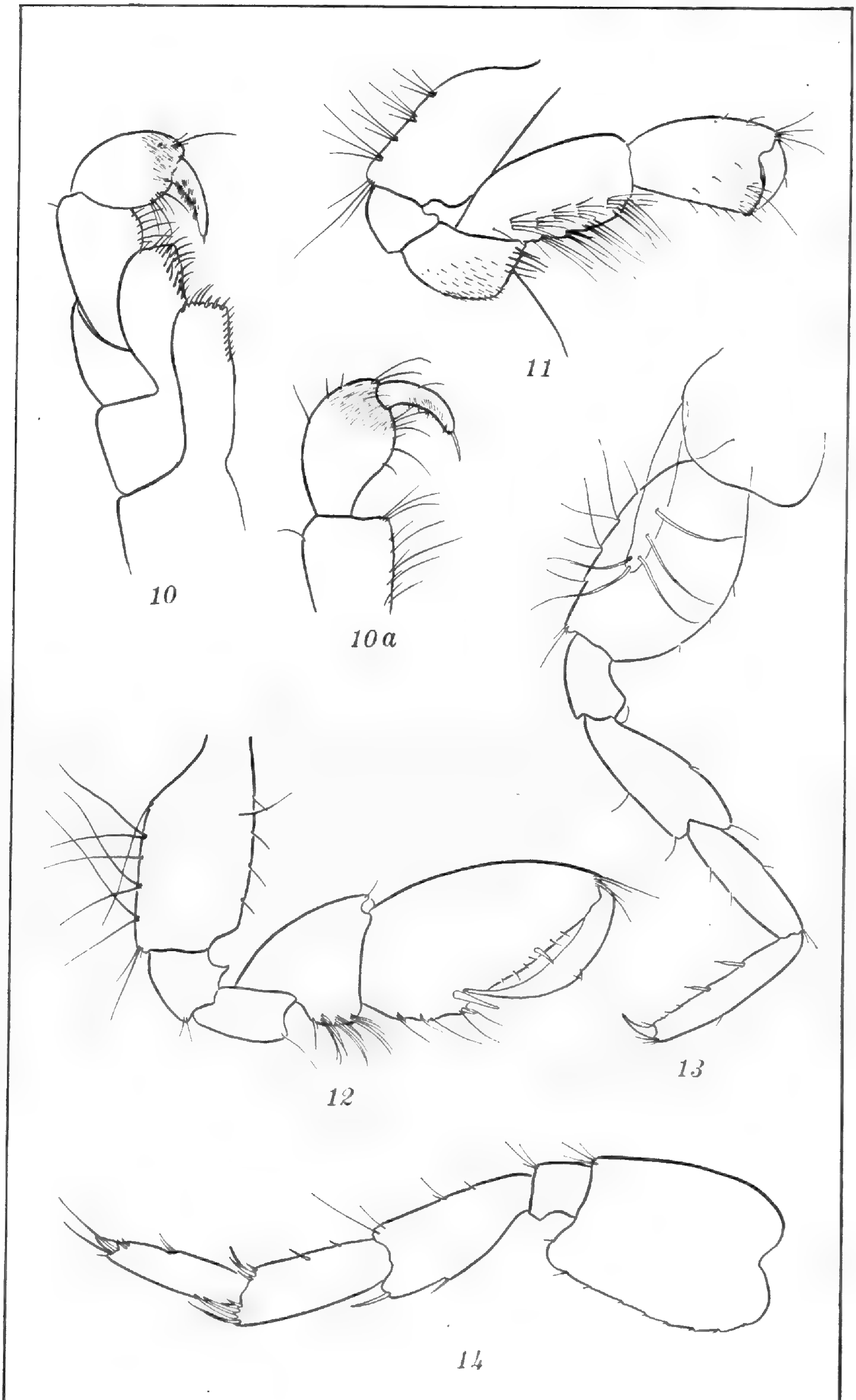


PLATE 2. NIPHARGUS PHILIPPENSIS SP. NOV.

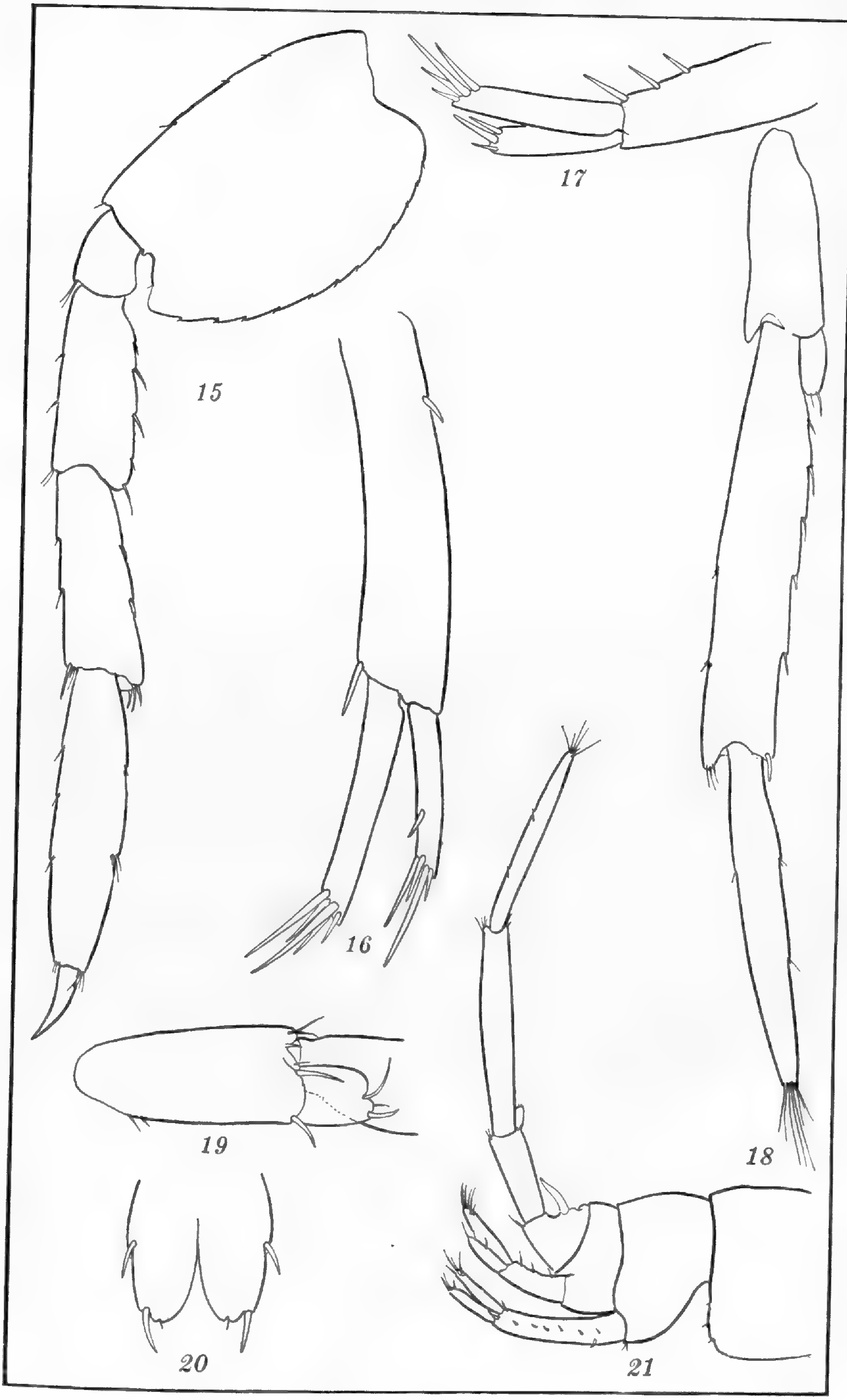


PLATE 3. NIPHARGUS PHILIPPENSIS SP. NOV.

# REVIEW

**The | Medical Clinics | of | North America | January, 1920, | published bi-monthly by | W. B. Saunders Company | Philadelphia and London | Paper, pp. 849–1165. $12 per year.**

The Boston Number, Volume 3, No. 4, contains the following papers:

Defects in membranous bones, exophthalmos and diabetes insipidus; an unusual syndrome of dyspituitarism, by Henry A. Christian.

Diabetes of long duration. Severe diabetes versus severe acidosis in diabetes, by Elliott P. Joslin.

Pericarditis, by William H. Robey.

Malignant disease of the lungs probably secondary to a hypernephroma of the kidneys, by Edwin A. Locke.

Studies in food poisoning—an experimental lunch with canned food containing bacteria, by M. J. Rosenau.

Vascular hypertension, by James P. O'Hare.

Gout, by C. W. McClure.

Two cases with chronic gastro-intestinal symptoms. Comments on the use of transfusion in pernicious anemia, by George R. Minot.

Certain types of pneumonia and serum treatment, by Frederick T. Lord.

The diagnostic value of electrocardiography of hearts beating regularly, by Paul D. White.

Albuminuria in young men, by Roger I. Lee.

Asthma, hay-fever, and allied conditions, by Francis M. Rackemann.

Hyperthyroidism—toxic goiter, by James H. Means.

Surgical anesthetics in diabetes mellitus, by Reginald Fitz.

Whooping-cough, by Fritz B. Talbot.

The treatment of the psychoneurtic, by Stanley Cobb.

Laboratory diagnosis, by Lesley H. Spooner.

# THE PHILIPPINE JOURNAL OF SCIENCE

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## THE RELATION OF SALT PROPORTIONS AND CONCENTRATIONS TO THE GROWTH OF YOUNG WHEAT PLANTS IN NUTRIENT SOLUTIONS CONTAINING A CHLORIDE [1]

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TWELVE TEXT FIGURES

### INTRODUCTION

For the development of higher plants the chemical elements carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, calcium, magnesium, potassium, and iron are unquestionably necessary. Carbon mainly derived from the carbon dioxide of the air, together with hydrogen and oxygen, which enter through the roots in the form of water, make up by far the greater portion of the plant substance. But the other necessary elements must be supplied and they also enter through the roots from aqueous solution. With the exception of iron, of which but little is needed, these essential elements must be furnished in relatively large amounts.

That higher plants require nitrogen, sulphur, phosphorus, calcium, magnesium, potassium, and iron in an aqueous solution about their roots was pointed out very early by Birner and Lucanus.[2] These writers supplied the necessary elements in

[1] Botanical contribution from the Johns Hopkins University, No. 58.

[2] Birner, H., and Lucanus, B., Wasserculturversuche mit Hafer. (In der agr.-chem. Versuchs-station zu Regenwalde i. J. 1864 durchgeführt.) Landw. Versuchsst. 8 (1866) 128–177.

the form of the salts monopotassium phosphate, calcium nitrate, magnesium sulphate, and ferric phosphate. Oat plants grown in solutions that lacked any of these elements were found to have much smaller dry weights than those grown in the full nutrient solution. Similar experiments by later workers with many other kinds of higher plants have given the same general results; namely, that the dry yield is much greater when all seven of these elements are present in the culture solution than when one or more of them are omitted.

Birner and Lucanus also showed that these seven are the only elements that are necessary for excellent growth of oat plants. There has been considerable discussion, however, among various writers as to whether certain other elements may not be essential for plants in general or for certain plants in particular. Nobbe and others, for example, believed that chlorine was necessary for the complete development of the buckwheat plant.[3] Beyer[4] reported that the fruiting of oats and peas was not normal in culture solutions that lacked chlorine. Also, Salm-Horstmar[5] was of the opinion that silicon and manganese were necessary for oats. But from all the work that has been done it may be concluded that for most higher plants only the seven elements mentioned above are to be regarded as essential constituents of the nutrient solution.

There still remains, however, the problem as to whether plant growth may not be significantly accelerated in the presence of nonessential elements, and modern investigators have studied the effects of a number of such elements. Of course it is well known that many unnecessary elements act as poisons and retard plant growth when supplied in certain concentrations, and the problem thus suggested has also been taken up by many writers.

[3] Nobbe, F., and Siegert, T., Ueber das Chlor als specifischen Nahrstoff der Buchweizenpflanze, Landw. Versuchsst. 4 (1862) 318–340, and 5 (1863) 116–136; Beiträge zur Pflanzencultur in wässerigen Nahrstoff Lösungen. II. Ueber das Chlor als Pflanzennahrstoff, Landw. Versuchsst. 6 (1864) 108–120. Nobbe, F., Ueber die physiologische Function des Chlor in der Pflanze, Landw. Versuchsst. 7 (1865) 371–386. Leydhecker, A., Ueber die physiologische Bedeutung des Chlor in der Buchweizenpflanze, Landw. Versuchsst. 8 (1866) 177–187.

[4] Beyer, A., Bericht über die im Sommer 1867 an der Versuchs-Station Regenwalde ausgeführten Wasserculturversuche, Landw. Versuchsst. 11 (1869) 262–287.

[5] Salm-Horstmar, Vers. und Resultäte üb. d. Nährung d. Pflanze. Braunschweig (1856).

Among the generally unessential elements that have been considered by investigators, chlorine is one of the commonest, and it has attracted considerable attention among agriculturists also. This element is frequently added to the soil as potassium chloride in fertilizer practice, and it has even been maintained that addition of sodium chloride to the soil results in an increased yield of certain crops. The present study deals with the influence of chlorine upon the growth of plants in a nutrient solution that also contains the seven essential elements.

Chlorine is not required in large amounts, since plants are able to grow and mature normally without appreciable amounts of this element. Birner and Lucanus (1886) concluded that chlorine was not essential; Knop,[6] after growing many kinds of plants, including buckwheat, also concluded that chlorine was unnecessary for normal development. Wagner[7] obtained apparently completely developed maize plants when no chlorine was in the culture solution. Recently Prianishnikov,[8] employing both the water-culture and the sand-culture methods, was unable to establish the necessity of this element. Shulov[9] concluded after several years of experimentation that chlorine is not necessary for the normal development of buckwheat plants.

Other investigators have found that many plants make very good growth without a chloride in the culture solution, and in no case has the necessity for the element chlorine been demonstrated. Crone,[10] using a nutrient solution without chlorine, found that rape, barley, grape, and maize made excellent growth.

Shive[11] found that young wheat plants made better growth in a three-salt nutrient solution, containing the same salts as employed by Birner and Lucanus, than in any chloride-containing solution that he tested. Buckwheat also matured in Shive's

[6] Knop, W., Quantitative Untersuchungen über den Ernährungsprocess der Pflanze, Landw. Versuchsst. 7 (1865) 93–107. Knop, W., and Dworzak, Ber. d. Sachs. Ges. d. Wiss. (1875) 61.

[7] Wagner, P., Wassercultur-Versuche mit Mais. III. Vegetations-Versuche mit chlorfreier Lösung, Landw. Versuchsst. 13 (1871) 218–222.

[8] Prianishnikov, D. N., Results of vegetation experiments in the years 1901–1903, Abstract in Exp. Sta. Rec. 18 (1906–1907) 320 and 321.

[9] Shulov, L. S., Various smaller experiments with fertilizers and soils, Abstract in Exp. Sta. Rec. 22 (1910) 223.

[10] Crone, G., Ergebnisse von Untersuchungen über die Wirkung der Phosphorsäure auf die höhere Pflanzen und eine neue Nahrlösung, Sitzungsber. Niederrhein. Gesell. Natur- und Heilkunde, Bonn (1902) 167–173.

[11] Shive, J. W., A three-salt nutrient solution for plants, Am. Journ. Bot. 2 (1915) 157–160. A study of physiological balance in nutrient media, Physiol. Res. 1 (1916) 327–397.

three-salt solutions containing no chlorides. Apparently normal seeds were obtained repeatedly by Johnston from buckwheat plants grown in one of Shive's solutions, without any chloride.[12]

In spite of the fact that these experiments show that chlorine is not required in any considerable amount, it is probable that plants have never been grown without containing at least small amounts of chlorine. Most plants contain some chlorine and, besides typical saline plants, many contain relatively large amounts of chlorine in their ash.[13] Since seeds probably always contain small amounts of this element, it cannot be regarded as actually proved that it is absolutely unnecessary. However, the fact that chlorine is found in the ash must not, of course, be considered proof that it is essential. Thus, sodium, silicon, aluminium, barium, strontium, manganese, zinc, arsenic, copper, boron, bromine, iodine, fluorine, cobalt, nickel, tin, and lead are all found in plant ash, and yet no experiments have shown that these are necessary to induce growth. But a very recent paper, of which I have seen only a brief review, appears to furnish evidence that very small amounts of chlorine are necessary for buckwheat. Pfeiffer and Simmermacher[14] studied the significance of chlorine in fertilization experiments. Chlorine is reported as indispensable for the growth of buckwheat; but the amount of chlorine considered to be required was very small, and larger quantities of chlorine compounds were regarded as injurious.

As with many other nonessential elements, plants may be altered in their manner of growth by supplying them with chlorine, in addition to the small amount contained in the seed. Such alterations may result in accelerated or retarded growth, increase or decrease in yield, etc., and chlorides may therefore be

[12] Johnston, E. S., Seasonal variations in the growth-rates of buckwheat plants under greenhouse conditions, Johns Hopkins Univ. Circular (March, 1917) 211–217.

[13] Hopkins, C. G., Soil Fertility and Permanent Agriculture. New York (1910) 603. Wolff, Emil, Aschen-Analysen von landwirtschaftlichen Producten, Fabrik-abfällen und wildwachsenden Pfianzen. I. Theil. Berlin (1871); Aschen-Analysen von land- und fortswirtschaftlichen Producten. II. Theil. Berlin (1880). Mangin, M. H., Sur la ficoideglaciale (Mesembrianthemum crystallinum), Compt. rend. Paris **96** (1883) 80–83.

[14] Pfeiffer, Th., and Simmermacher, W., Landw. Versuchsst. **88** 105–120. through Chem. Zentralbl. **1** (1916) 1186, and Chem. Abs. **11** (1917) 3365.

considered as beneficial or injurious, depending upon the desirability or undesirability of the changes produced by their use.

Tottingham [15] presents a review of the literature on the effects of chlorides on plant growth, and reports experimental studies on the influence of chlorides on the growth of a number of agricultural plants. He reports that the introduction of potassium and sodium chlorides into solution cultures had little effect on wheat seedlings. Both yield of dry matter and length of roots were depressed in buckwheat grown to maturity in similar cultures. In soil cultures, radish was affected only slightly by chlorides; increased production of dry matter and sugar content resulted with carrot, while the reverse was true of parsnip. Sugar beet, in soil cultures, produced more watery roots and a greater amount of dry matter; the roots contained more glucose, but less sucrose. Similar responses followed the application of common salt alone to beets grown in the field. The potato produced increased yields of dry matter in the tuber when potassium chloride was supplied in place of potassium sulphate, in a complete fertilizer ration, to soil cultures in the greenhouse. Different varieties responded differently according to the percentage of starch. In field cultures in a dry season the application of potassium chloride in a complete fertilizer decreased the yield of dry matter in the tubers, but not the percentage of marketable tubers, of the Triumph variety. In a season that was very humid toward its close, no significant differences in composition or cooking qualities were found between tubers of the Rural New Yorker variety produced, when potassium sulphate and potassium chloride were employed separately in a complete fertilizer ration. Sodium chloride applied alone altered the composition of the tubers only slightly, but affected their quality seriously. It has, of course, been found that growth may be retarded when chlorides are supplied in very large amounts.[16]

[15] Tottingham, W. E., A preliminary study of the influence of chlorides upon the growth of certain agricultural plants, Journ. Am. Soc. Agron. 11 (1919) 1–32.

[16] Wheeler, H. J., and Hartwell, B. J., Conditions determining the poisonous action of chlorides, Rhode Island Exp. Sta. Ann. Rep. 15 (1901–1902) 287–304.

Increased growth is reported to have followed the application of sodium chloride to the soil, especially in the case of experiments carried out in the British Isles.[17] From the point of view of physiology it is of course possible that under certain conditions the addition of chlorides to a nutrient solution may produce increased growth, as has been found for many salts of proved toxic action.[18]

Not only alterations in the amount of substance produced but also changes in the structure and physiological nature of plants have been brought about by the addition of chlorides to the nutrient medium.[19] Harter [20] found that the addition of sodium chloride to the soil of experimental cultures might either increase or decrease the transpiration rate, and alter the structure of wheat, oat, and barley plants.

It is possible that chlorides may affect certain special metabolic processes and thus influence the plant more in one stage of its development than in another. Nobbe and his coworkers reported that chlorides were beneficial for the production of seed by buckwheat plants. He considered that this result was due to an influence exerted by chlorine upon the translocation of carbohydrate food; but Nobbe's observations have not been substantiated by more recent research.

It seems to be well established that many kinds of plants may be grown successfully in liquid media without any chloride. Nevertheless, most of the culture solutions recommended in the literature of plant physiology include a chloride. The following solutions may be mentioned as belonging to this class:

[17] Dyer, B., Field experiments on cabbages at Rusper, Horsham, Journ. Roy. Agric. Soc. England, II 23 (1887) 425–430. Gonehalli, V. H., Common salt and its use as manure in the Konkan Division, Dept. Agric. Bombay Bull. 29, 19 pp. 1914. Voelcker, G. A., Experiments on the use of salt for mangolds, Journ. Roy. Agric. Soc. England 69 (1908) 355–366. Griffiths, A. B., A treatise on Manure, or the Philosophy of Manuring. London (1889) 399 pp.

[18] Brenchley, W. E., Inorganic Plant Poisons and Stimulants. Cambridge (1914) 110 pp.

[19] Hansteen, B., Ueber das Verhalten der Kulturpflanzen zu den Bodensalzen, I. and II. Jahrb. f. wiss. Bot. 47 (1910) 289–376.

[20] Harter, L. L., The influence of a mixture of soluble salts, principally sodium chloride, upon the leaf structure and transpiration of wheat, oats, and barley, Bull. U. S. Dept. Agric. Bur. Pl. Ind. 134 (1908) 22 pp.

Sachs:[21] NaCl, $CaSO_4$, $MgSO_4$, $Ca_3(PO_4)_2$, $KNO_3$.
Nobbe:[22] KCl, $MgSO_4$, $KH_2PO_4$, $Ca(NO_3)_2$.
Tollens:[23] NaCl, $MgSO_4$, $KH_2PO_4$, $KNO_3$, $Ca(NO_3)_2$.
Schimper:[24] NaCl, $MgSO_4$, $K_2HPO_4$, $KNO_3$, $Ca(NO_3)_2$.
Detmer:[25] KCl, $MgSO_4$, $KH_2PO_4$, $Ca(NO_3)_2$.
Pfeffer:[26] KCl, $MgSO_4$, $KH_2PO_4$, $KNO_3$, $Ca(NO_3)_2$.
Hartwell, Wheeler, and Pember:[27] KCl, $MgSO_4$, $Ca(NO_3)_2$, $Ca(H^2PO_4)_2$.
Stiles:[28] NaCl, $MgSO_4$, $KH_2PO_4$, $KNO_3$, $CaSO_4$.
Brenchley:[29] NaCl, $MgSO_4$, $KH_2PO_4$, $KNO_3$, $CaSO_4$.

On the other hand, very few nutrient solutions without a chloride have been recommended for plant cultures. Of this smaller group the following are familiar examples:

Knop (Tottingham):[30] $MgSO_4$, $KH_2PO_4$, $KNO_3$, $Ca(NO_3)_2$.

[21] Sachs, J., Bericht über die physiologische Thätigkeit an der Versuchsstation in Tharandt. IV. Vegetations-Versuche mit Ausschlus des Bodens über die Nährstoffe und sonstigen Ernährungsbedingungen von Mais, Bohnen und anderen Pflanzen, Landw. Versuchsst. 2 (1860) 219–268.

[22] Nobbe, F., Ueber die physiologische Function des Chlor in der Pflanze, Landw. Versuchsst. 7 (1865) 371–386.

[23] Tollens, B., Ueber einige Erleichterungen bei der Cultur von Pflanzen in wässerigen Lösungen, Journ. Landw. 30 (1882) 537–540.

[24] Schimper, A. F. W., Zur Frage der Assimilation der Mineralsälze durch die grüne Pflanze, Flora 73 (1890) 207–261.

[25] Detmer, W., Practical plant physiology. Translated by S. A. Moor. London (1898) 2.

[26] Pfeffer, W., The physiology of plants. Translated by A. J. Ewart. Oxford 1 (1900) 420.

[27] Hartwell, B. F.; Wheeler, H. J.; and Pember, F. R.; The effect of the addition of sodium to deficient amounts of potassium upon the growth of plants in both water and sand cultures, Rhode Island Agric. Exp. Sta. Ann. Rep. 20 (1907) 299–357.

[28] Stiles, W., On the relation between the concentration of the nutrient solution and the rate of growth of plants in water culture, Ann. Bot. 29 (1915) 89–96.

[29] Brenchley, W. E., The effect of the concentration of the nutrient solution on the growth of barley and wheat in water cultures, Ann. Bot. 30 (1916) 77–90.

[30] Knop, W., Quantitativ-analytische Arbeiten über den Ernährungsprocess der Pflanzen. II. Landw. Versuchsst. 4 (1862) 173–187. Tottingham, W. E., A quantitative chemical and physiological study of nutrient solutions for plant cultures, Physiol. Res. 1 (1914) 133–245.

Birner and Lucanus (Shive):[31] $MgSO_4$, $KH_2PO_4$, $Ca(NO_3)_2$.
Crone:[32] $CaSO_4$, $MgSO_4$, $Ca_3(PO_4)_2$, $KNO_3$.

The study to be reported in the present paper was undertaken, as has been stated, to throw more light upon the problem as to what may be the physiological influence upon plants of considerable amounts of potassium chloride in a nutrient solution that also contains other salts supplying all the essential elements.

This investigation was carried out at the Laboratory of Plant Physiology of the Johns Hopkins University, under the direction of Prof. B. E. Livingston, to whom I am indebted for valuable assistance during its progress and for aid in the preparation of this paper. I am also indebted to Dr. H. E. Pulling for many suggestions.

## GENERAL METHODS

The experimental work comprised four series of cultures carried out at different times. The first two of these were planned to furnish a general survey of the relations between plant growth and salt porportions with a single total concentration of the solution (osmotic value 1.60 atmospheres). The results obtained from these two series made it appear desirable to test the effects of higher partial concentrations of potassium chloride than had been originally planned, and the third series included such tests. Finally, the influence of the total concentration of the medium was studied for four selected sets of salt proportions; these tests made up the fourth series. The present section will begin with an account of the general methods employed in all four series. This will be followed by a more detailed account of the methods employed, the results obtained, and a discussion of these results for each of the series taken in order.

In the nutrient solutions of the present study the essential elements (besides iron) were supplied as monopotassium phosphate, calcium nitrate, and magnesium sulphate, and the chloride ion was added by the introduction of potassium chloride.

[31] Birner, H., and Lucanus, B., Wasserculturversuche mit Hafer. (In der agr.-chem. Versuchsstation zu Regenwalde i. J. 1864 durchgeführt.) Landw. Versuchsst. 8 (1866) 128–177. Shive, J. W., A study of physiological balance in nutrient media, Physiol. Res. 1 (1915) 327–397.

[32] Crone, G., Ergebnisse von Untersuchungen über die Wirkung der Phosphorsäure auf die höhere Pflanzen und eine neue Nahrlösung. Sitzungsber. Niederrhein. Nat.- und Heilkunde. Bonn. (1902) 167–173.

Thus the solutions here considered are four-salt solutions, and they are similar in their general make-up to the other four-salt solutions already employed by Tottingham. It will be seen that a solution made up of monopotassium phosphate, calcium nitrate, magnesium sulphate, and potassium chloride may be derived from the proper one of Shive's three-salt series by the addition of potassium chloride. These four salts have been employed in Nobbe's solution in a single set of proportions and in the so-called Detmer's solution in another set of proportions, as pointed out above. The present study aimed primarily to employ these four salts in various proportions, the total concentration of the solution remaining the same. The effects of different total concentrations with a constant set of salt proportions was also studied to some extent.

*Culture solutions.*—The culture solutions, whose compositions are given among the other data of the individual experiments, were prepared from analyzed chemicals [33] and water obtained from a "Barnstead" still. Each salt was dissolved separately, and the exact concentration of the resulting solution was determined by chemical analysis (except in the case of potassium chloride). This procedure is especially necessary for solutions of calcium nitrate and of magnesium sulphate, because these salts contain amounts of water of crystallization that vary between wide limits, and because they are rather readily decomposed by heat. Upon dilution to convenient volume-molecular concentrations,[34] these solutions became the "stock solutions" from which the various culture media were prepared. The stock solutions were stored (never longer than one month) in cork-stoppered glass bottles.

Ferric phosphate (used as a source of iron) was prepared from a ferric nitrate solution by precipitation with a one-fourth molecular solution of monopotassium phosphate. The precipitate was obtained in a finely divided condition by using cold solutions and by constantly stirring while the potassium salt was added. After thoroughly washing the precipitate, it was shaken with sufficient water to form a suspension containing approximately 0.0022 gram of ferric phosphate, or 0.0008 gram of iron, in each cubic centimeter.

[33] The potassium chloride was the Baker and Adamson Chemical Company's "analyzed" salt; the other salts were the J. T. Baker Chemical Company's "analyzed" salts.

[34] By volume-molecular concentration is meant the number of gram molecules contained in each liter of solution.

For the preparation of the culture solutions, the required amount of each stock solution was drawn from a burette into a volumetric flask partially filled with distilled water, and the flask was finally filled to the mark with more water. For the cultures in series IV, in which culture solutions ranging from 0.50 to 7.00 atmospheres were employed, stock culture solutions of 7.00 atmospheres were prepared and the less-concentrated culture solutions were made by proper dilution. The culture solutions were poured from the volumetric flasks into the culture jars, and two drops of the suspension of ferric phosphate were added to each complete solution. The culture jars were wide-mouthed glass bottles of 250 cubic centimeters capacity, which had been used for several years in similar experiments.

*The plants.*—The wheat seeds used in these studies were supplied by the Bureau of Plant Industry of the United States Department of Agriculture. The variety was "Fulcaster," C. I. No. 1918, grown at the Arlington Experiment Farm, Arlington, Va., in 1915. The seeds were germinated in moist chambers and then transferred to a netting germinator. At the end of about five days, when the seedlings were from 8 to 10 centimeters high, they were transferred from the germinator to the culture solutions.

The internal differences between seedlings grown from the same stock of seed and exposed to pratically identical external conditions constitute a source of great difficulty in work with water-cultures.[35] To minimize such variations, seedlings were selected that were as nearly alike as possible, this selection being made on the basis of the appearance of the seedlings. Two selections were made, the first when the sprouted seeds were transferred to the netting germinators, and the second when the plants were transferred to the culture jars.

Six seedlings were used in each culture. These were supported by cotton in holes near the margin of the cork, the seed remnants remaining below the cork. To prevent entrance of light to the roots, the jars were covered with cardboard covers.

The method of supporting the stem and leaves is important, because the rate of transpiration, and probably that of photosyn-

[35] This has been emphasized by Stiles. Stiles, W., On the relation between the concentration of the nutrient solution and the rate of growth of plants in water culture, Ann. Bot. 29 (1915) 89–96. Observations on the influence of aeration of the nutrient solution in water culture experiments, with some remarks on the water culture method, New Phytol. 16 (1917) 181–197.

thesis and other processes, may be greatly modified by the way in which the leaves are exposed to the air. The pointed end of a cylindrical wooden rod (a quarter-inch dowel), 6 millimeters in diameter and 30 centimeters long, was set into a hole in the center of the cork. A loop (5 centimeters in diameter) of paraffined copper wire, the lower part of which was wrapped around the rod several times, was used to hold the plant erect.[36] As the height of the plants increased, the loop was raised on the rod. Care was taken to support all the plants in the same way.

The same aërial conditions were secured for all the cultures in a series by rotating the cultures near the margins of the circular tables described by Shive. Each of the cultures was thus exposed to approximately the same changes in light, temperature, and humidity conditions.

The frequency with which the culture solutions are renewed is very important in experiments with solution cultures.[37] The solutions here used were changed every four days. Thus the period between changing is not strictly comparable with that used by Shive and by Tottingham, each of whom employed a three-day period. When the solutions were changed the decrease in volume of the solution during the previous period was measured, and the amount of solution found to have been removed was taken as an approximate measure of the amount of water absorbed and transpired during the period.

The developmental stage of the plants probably has an important bearing on their salt requirements.[38] The present study is concerned only with the early vegetative stage of the young wheat plants. When transferred from the germinators to the

[36] For photograph see McCall, A. G., A new method for the study of plant nutrients in sand cultures, Journ. Amer. Soc. Agron. 7 (1915) 250–252.

[37] Trelease, S. F., and Free, E. E., The effect of renewal of the culture solutions on the growth of young wheat plants in water-cultures, Johns Hopkins Univ. Circ. N. S. No. 3 (March, 1917) 227 and 228. Merrill, M. C., Some relations of plants to distilled water and certain dilute toxic substances, Ann. Missouri Bot. Gard. 2 (1915) 459–606. Stiles, W., On the interpretation of the results of water culture experiments, Ann. Bot. 30 (1916) 427–436. Brenchley, W. E., The effect of the concentration of the nutrient solution on the growth of barley and wheat in water cultures, Ann. Bot. 30 (1916) 77–90.

[38] Pember, F. R., Studies by means of both pot and solution cultures of the phosphorous and potassium requirements of the barley plant during its different periods of growth, Bull. Agric. Exp. Sta. Rhode Island State College 169 (1917) 1–50.

culture solutions the plants were about five days old. They were grown in the culture solutions, renewed every four days, for twenty-four days, except in the case of series III and IV in which the growth period was extended to thirty-two days.

At the end of the growth period the plants were harvested for the determination of their dry weight. Notes were made at this time of the appearance of the tops and roots, special attention being given to apparent pathological conditions that might indicate injury from unbalanced salt nutrition. The tops and roots were harvested separately, the roots being severed from the tops at the point of attachment of the seed.[39] The tops and roots were dried separately for about two days, at a temperature of 102–105° C., to approximately constant weight, and the dry weights were then determined.

The experiments were conducted in one of the greenhouse rooms of the Laboratory of Plant Physiology, on the outskirts of the city of Baltimore. The evaporating power of the air for the period of each experiment was determined by means of Livingston white spherical porous-cup atmometers,[40] one of the instruments being operated on each of the rotating tables. The atmometer bottle was placed 10 centimeters from the center of the table, the top of the sphere being 40 centimeters above the table top. The atmometers were read every four days, when the solutions were changed. A record of fluctuations in temperature was obtained by means of a Richard thermograph placed in the shade near the plants.

## SERIES I

### METHODS OF SERIES I

Series I was continued for twenty-four days, from January 11 to February 4, 1916. During this period the highest air temperature was 29° C., on January 26, and the lowest was 10° C., on January 17. The average daily maximum temperature for the period was 25° C., and the average daily minimum 18° C. The mean daily water loss from a white spherical porous-cup atmometer, indicating the evaporating power of the air, was 17.2

[39] The seed-coat remnants were dried and weighed with the roots; Shive discarded them.

[40] Livingston, B. E., Atmometry and the porous cup atmometer, Plant World 18 (1915) 21–30, 51–74, 95–111, 143–149. Also reprinted, Tucson, Ariz. (1915).

cubic centimeters, and the total loss for the entire period was 415 centimeters.

The general plan of this series is similar to that employed by Tottingham. Eighty-four solutions were made from four salts: potassium chloride, monopotassium phosphate, calcium nitrate, and magnesium sulphate. In each solution the four salts were so proportioned that the total concentration of each solution corresponded to 1.6 atmospheres of osmotic pressure at 25° C., and in the different solutions the proportion of each salt was varied by 0.1 of the total osmotic concentration of all salts. The lowest concentration of any salt was thus 0.1 of the total concentration and the greatest 0.7. All of the possible different proportions were used that could be produced by these variations. Thus, there were eighty-four different solutions in this series, all of which had approximately the same total osmotic concentration, but no two of which had the same set of salt proportions. This may be stated in another way by saying that all of the solutions were planned to have the same total number of particles (ions plus molecules) per unit volume, but no two solutions the same proportions of the different kinds of particles. Besides the eighty-four solutions belonging in the series, Shive's best three-salt solution for wheat and Tottingham's best four-salt solution for wheat were employed for the sake of comparison.

If three salts had been employed instead of four, the compositions of the solutions could have been represented graphically by means of points placed in an equilateral triangle, the points being so placed that the least concentration of one salt would have been along one side of the triangle and the greatest at the opposite angle. As four salts were used, a figure representing their various proportions assumes the form of a regular tetrahedron. In this figure each face of the tetrahedron represents 0.1 concentration of one salt and the opposite apex 0.7. Since seven proportions of each salt were employed, different concentrations of the salt whose lowest concentration is represented by the base of the figure will fall in seven planes. For convenience of graphical presentation the planes representing the different concentrations of potassium chloride have been plotted separately (fig. 1). Since only one culture that had the greatest concentration of potassium chloride was used, the plane which passes through the apex is represented by a point; the

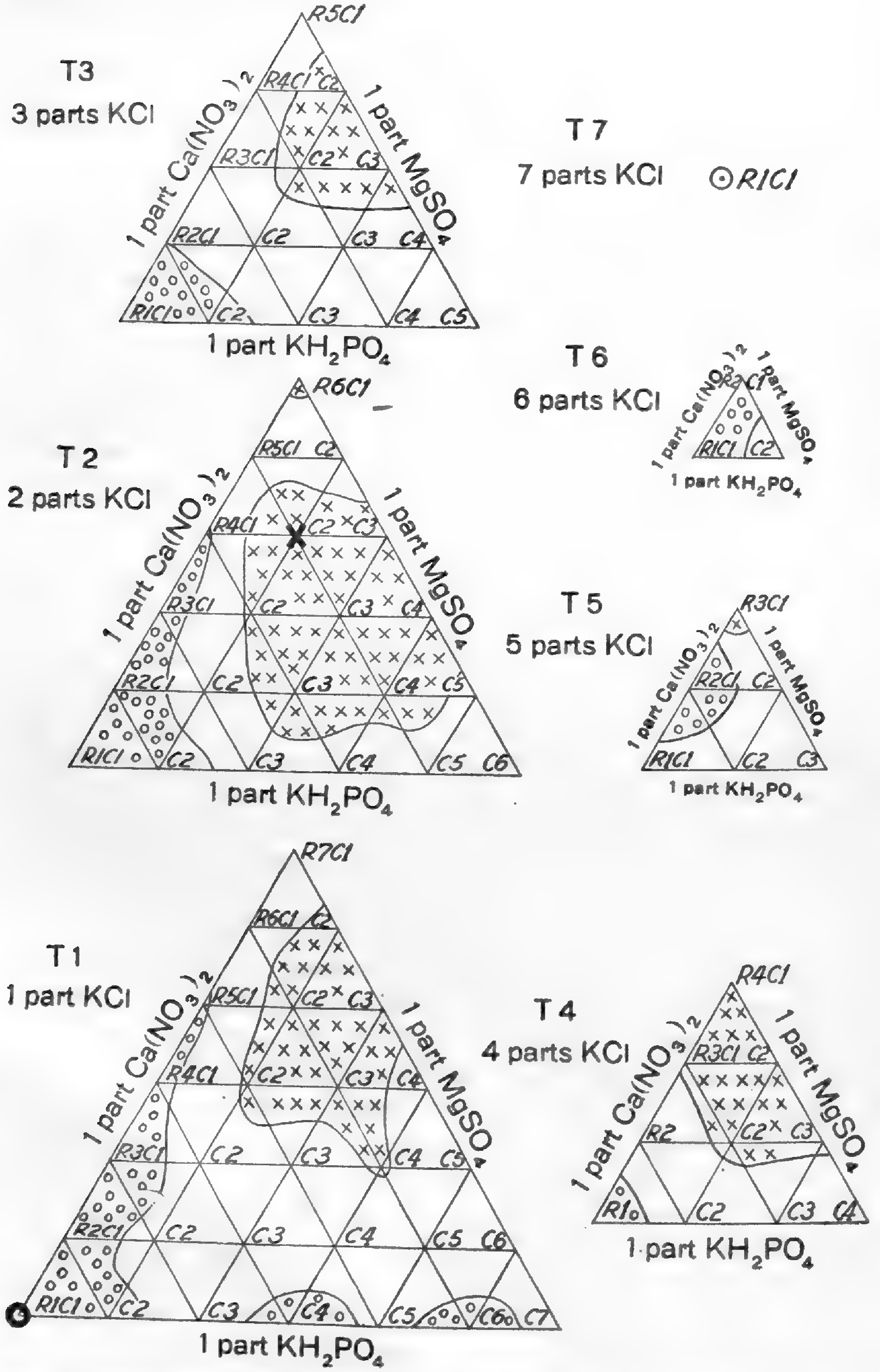


FIG. 1. Diagram for series I, showing culture numbers and osmotic proportions of the four salts.

other planes are represented by triangles. The seven triangles in fig. 1 (numbered T1 to T7) represent as many horizontal planes passed through the tetrahedron and all the points upon any one triangle denote solutions having the same partial concentration of potassium chloride. Similarly, the position of a point upon any one of the triangles indicates the osmotic proportions of the other three salts in the corresponding solution. The lines are so drawn that their intersections represent the salt proportions actually employed. It will be seen that there are twenty-eight solutions (triangle 1) that are characterized by having 0.1 of their total osmotic concentration due to potassium chloride, while there is but one solution (triangle 7) in which 0.7 is due to this salt.[41] Each solution will be designated by a triple number, the first part denoting the triangle (as T2), the second the horizontal row of intersections in that triangle (as R3), and the third representing the number of the intersection in the row, counted from left to right (as C2). The solution just described is thus named T2R3C2, and the four salts contribute, respectively, the following proportions of the total concentration: potassium chloride, 0.2; monopotassium phosphate, 0.3; calcium nitrate, 0.2; and magnesium sulphate, 0.3. The triangle number gives the number of tenths due to potassium chloride, the row number gives the number of tenths due to monopotassium phosphate, and the culture number gives the number of tenths due to calcium nitrate. The number of tenths of the total concentration due to the fourth salt (magnesium sulphate) is found by subtracting from 10 the sum of the numbers appearing in the designation of the solution.

The actual chemical composition of each of the eighty-four solutions in series I is given in Table 1, in terms of the volume-molecular partial concentrations of the four salts. The first column of this table gives the culture numbers of the solutions just described, and the last three columns give the three cation-ratio values of each solution, which will be referred to later. To obtain these concentration values, it was necessary to calculate the volume-molecular partial concentrations of each salt that would produce 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, and 0.7 of 1.60 atmospheres of osmotic pressure at 25° C. The values thus obtained are given in Table 2.

[41] For a more detailed discussion of the interpretation of this kind of diagram, Tottingham's paper may be referred to.

**Table 1.**—*Partial concentrations of potassium chloride, monopotassium phosphate, calcium nitrate, and magnesium sulphate in each of the solutions employed in series I; also the values of the three cation ratios; total osmotic value of each solution, 1.60 atmospheres.*

| Culture No. | Volume-molecular concentration. | | | | Cation-ratio value. | | |
|---|---|---|---|---|---|---|---|
| | KCl. | $KH_2PO_4$. | Ca $(NO_3)_2$. | $MgSO_4$. | Mg/Ca. | Mg/K. | Ca/K. |
| | *M.* | *M.* | *M.* | *M.* | | | |
| T1R1C1 | 0.0033 | 0.0033 | 0.0023 | 0.0309 | 13.43 | 4.68 | 0.35 |
| C2 | 0.0033 | 0.0033 | 0.0047 | 0.0261 | 5.55 | 3.95 | 0.71 |
| C3 | 0.0033 | 0.0033 | 0.0072 | 0.0216 | 3.00 | 3.27 | 1.09 |
| C4 | 0.0033 | 0.0033 | 0.0098 | 0.0171 | 1.75 | 2.59 | 1.48 |
| C5 | 0.0033 | 0.0033 | 0.0124 | 0.0126 | 1.02 | 1.91 | 1.88 |
| C6 | 0.0033 | 0.0033 | 0.0150 | 0.0081 | 0.54 | 1.23 | 2.27 |
| C7 | 0.0033 | 0.0033 | 0.0177 | 0.0038 | 0.21 | 0.58 | 2.68 |
| R2C1 | 0.0033 | 0.0068 | 0.0023 | 0.0261 | 11.35 | 2.58 | 0.23 |
| C2 | 0.0033 | 0.0068 | 0.0047 | 0.0216 | 4.60 | 2.14 | 0.47 |
| C3 | 0.0033 | 0.0068 | 0.0072 | 0.0171 | 2.38 | 1.69 | 0.71 |
| C4 | 0.0033 | 0.0068 | 0.0098 | 0.0126 | 1.29 | 1.25 | 0.97 |
| C5 | 0.0033 | 0.0068 | 0.0124 | 0.0081 | 0.65 | 0.80 | 1.23 |
| C6 | 0.0033 | 0.0068 | 0.0150 | 0.0038 | 0.25 | 0.38 | 1.49 |
| R3C1 | 0.0033 | 0.0103 | 0.0023 | 0.0216 | 9.39 | 1.59 | 0.17 |
| C2 | 0.0033 | 0.0103 | 0.0047 | 0.0171 | 3.64 | 1.26 | 0.35 |
| C3 | 0.1033 | 0.0103 | 0.0072 | 0.0126 | 1.75 | 0.93 | 0.53 |
| C4 | 0.0033 | 0.0103 | 0.0098 | 0.0081 | 0.83 | 0.60 | 0.72 |
| C5 | 0.0033 | 0.0103 | 0.0124 | 0.0038 | 0.31 | 0.28 | 0.91 |
| R4C1 | 0.0033 | 0.0138 | 0.0023 | 0.0171 | 7.44 | 1.00 | 0.13 |
| C2 | 0.0033 | 0.0138 | 0.0047 | 0.0126 | 2.68 | 0.74 | 0.27 |
| C3 | 0.0033 | 0.0138 | 0.0072 | 0.0081 | 1.13 | 0.47 | 0.42 |
| C4 | 0.0033 | 0.0138 | 0.0098 | 0.0038 | 0.39 | 0.22 | 0.57 |
| R5C1 | 0.0033 | 0.0173 | 0.0023 | 0.0126 | 5.48 | 0.61 | 0.11 |
| C2 | 0.0033 | 0.0173 | 0.0047 | 0.0081 | 1.72 | 0.39 | 0.23 |
| C3 | 0.0033 | 0.0173 | 0.0072 | 0.0038 | 0.53 | 0.18 | 0.35 |
| R6C1 | 0.0033 | 0.0208 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0033 | 0.0208 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R7C1 | 0.0033 | 0.0243 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T2R1C1 | 0.0067 | 0.0033 | 0.0023 | 0.0261 | 11.35 | 2.61 | 0.23 |
| C2 | 0.0067 | 0.0033 | 0.0047 | 0.0216 | 4.60 | 2.16 | 0.47 |
| C3 | 0.0067 | 0.0033 | 0.0072 | 0.0171 | 2.38 | 1.71 | 0.72 |
| C4 | 0.0067 | 0.0033 | 0.0098 | 0.0126 | 1.29 | 1.26 | 0.98 |
| C5 | 0.0067 | 0.0033 | 0.0124 | 0.0081 | 0.65 | 0.81 | 1.24 |
| C6 | 0.0067 | 0.0033 | 0.0150 | 0.0038 | 0.25 | 0.38 | 1.50 |
| R2C1 | 0.0067 | 0.0068 | 0.0023 | 0.0216 | 9.39 | 1.60 | 0.17 |
| C2 | 0.0067 | 0.0068 | 0.0047 | 0.0171 | 3.64 | 1.27 | 0.35 |
| C3 | 0.0067 | 0.0068 | 0.0072 | 0.0126 | 1.75 | 0.93 | 0.53 |
| C4 | 0.0067 | 0.0068 | 0.0098 | 0.0081 | 0.83 | 0.60 | 0.73 |
| C5 | 0.0067 | 0.0068 | 0.0124 | 0.0038 | 0.31 | 0.28 | 0.92 |
| R3C1 | 0.0067 | 0.0103 | 0.0023 | 0.0171 | 7.44 | 1.01 | 0.14 |
| C2 | 0.0067 | 0.0103 | 0.0047 | 0.0126 | 2.68 | 0.74 | 0.28 |
| C3 | 0.0067 | 0.0103 | 0.0072 | 0.0081 | 1.13 | 0.48 | 0.42 |
| C4 | 0.0067 | 0.0103 | 0.0098 | 0.0038 | 0.39 | 0.22 | 0.58 |

TABLE 1.—*Partial concentrations of potassium chloride, monopotassium phosphate, calcium nitrate, and magnesium sulphate in each of the solutions employed in series I; also the values of the three cation ratios; total osmotic value of each solution, 1.6 atmospheres*—Continued.

| Culture No. | Volume-molecular concentration. | | | | Cation-ratio value. | | |
|---|---|---|---|---|---|---|---|
| | KCl. | $KH_2PO_4$. | $Ca(NO_3)_2$ | $MgSO_4$. | Mg/Ca. | Mg/K. | Ca/K. |
| | *M.* | *M.* | *M.* | *M.* | | | |
| T2R4C1 | 0.0067 | 0.0138 | 0.0023 | 0.0126 | 5.48 | 0.61 | 0.11 |
| C2 | 0.0067 | 0.0138 | 0.0047 | 0.0081 | 1.72 | 0.40 | 0.23 |
| C3 | 0.0067 | 0.0138 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| R5C1 | 0.0067 | 0.0173 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0067 | 0.0173 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R6C1 | 0.0067 | 0.0208 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T3R1C1 | 0.0101 | 0.0033 | 0.0023 | 0.0216 | 9.39 | 1.61 | 0.17 |
| C2 | 0.0101 | 0.0033 | 0.0047 | 0.0171 | 3.64 | 1.28 | 0.35 |
| C3 | 0.0101 | 0.0033 | 0.0072 | 0.0126 | 1.75 | 0.94 | 0.54 |
| C4 | 0.0101 | 0.0033 | 0.0098 | 0.0081 | 0.83 | 0.60 | 0.73 |
| C5 | 0.0101 | 0.0033 | 0.0124 | 0.0038 | 0.31 | 0.28 | 0.93 |
| R2C1 | 0.0101 | 0.0068 | 0.0023 | 0.0171 | 7.44 | 1.01 | 0.14 |
| C2 | 0.0101 | 0.0068 | 0.0047 | 0.0126 | 2.68 | 0.75 | 0.28 |
| C3 | 0.0101 | 0.0068 | 0.0072 | 0.0081 | 1.13 | 0.48 | 0.43 |
| C4 | 0.0101 | 0.0068 | 0.0098 | 0.0038 | 0.39 | 0.22 | 0.58 |
| R3C1 | 0.0101 | 0.0103 | 0.0023 | 0.0126 | 5.48 | 0.62 | 0.11 |
| C2 | 0.0101 | 0.0103 | 0.0047 | 0.0081 | 1.72 | 0.40 | 0.23 |
| C3 | 0.0101 | 0.0103 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| R4C1 | 0.0101 | 0.0138 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0101 | 0.0138 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R5C1 | 0.0101 | 0.0173 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T4R1C1 | 0.0135 | 0.0033 | 0.0023 | 0.0171 | 7.44 | 1.02 | 0.14 |
| C2 | 0.0135 | 0.0033 | 0.0047 | 0.0126 | 2.68 | 0.75 | 0.28 |
| C3 | 0.0135 | 0.0033 | 0.0072 | 0.0081 | 1.13 | 0.48 | 0.43 |
| C4 | 0.0135 | 0.0033 | 0.0098 | 0.0038 | 0.39 | 0.23 | 0.58 |
| R2C1 | 0.0135 | 0.0068 | 0.0023 | 0.0126 | 5.48 | 0.62 | 0.11 |
| C2 | 0.0135 | 0.0068 | 0.0047 | 0.0081 | 1.72 | 0.40 | 0.23 |
| C3 | 0.0135 | 0.0068 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| R3C1 | 0.0135 | 0.0103 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0135 | 0.0103 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R4C1 | 0.0135 | 0.0138 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T5R1C1 | 0.0170 | 0.0033 | 0.0023 | 0.0126 | 5.48 | 0.62 | 0.11 |
| C2 | 0.0170 | 0.0033 | 0.0047 | 0.0081 | 1.72 | 0.40 | 0.23 |
| C3 | 0.0170 | 0.0033 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| R2C1 | 0.0170 | 0.0068 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0070 | 0.0068 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R3C1 | 0.0170 | 0.0103 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T6R1C1 | 0.0205 | 0.0033 | 0.0023 | 0.0081 | 3.52 | 0.34 | 0.10 |
| C2 | 0.0205 | 0.0033 | 0.0047 | 0.0038 | 0.81 | 0.16 | 0.20 |
| R2C1 | 0.0205 | 0.0068 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T7R1C1 | 0.0240 | 0.0033 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |

TABLE 2.—*Partial concentrations of each of the four salts required to produce from 0.1 to 0.7 of the total osmotic concentration of 1.60 atmospheres for series I.*

| Fractional parts of 1.60 atmospheres. | KCl. | $KH_2PO_4$. | $Ca(NO_3)_2$. | $MgSO_4$. |
|---|---|---|---|---|
| | *M.* | *M.* | *M.* | *M.* |
| 0.1 | 0.0033 | 0.0033 | 0.0023 | 0.0038 |
| 0.2 | 0.0067 | 0.0068 | 0.0047 | 0.0081 |
| 0.3 | 0.0101 | 0.0103 | 0.0072 | 0.0126 |
| 0.4 | 0.0135 | 0.0138 | 0.0098 | 0.0171 |
| 0.5 | 0.0170 | 0.0173 | 0.0124 | 0.0216 |
| 0.6 | 0.0205 | 0.0208 | 0.0150 | 0.0261 |
| 0.7 | 0.0240 | 0.0243 | 0.0177 | 0.0309 |

The method used in these calculations may be illustrated with potassium chloride, the calculations for the other salts being made in the same way. It was first necessary to obtain certain physico-chemical data regarding each of the four salts dealt with, and these data as used for potassium chloride are given in Table 3. The numbers in the first column represent the tenths (from 0.1 to 0.7) of the total concentration of 1.60 atmospheres. Those in the second column represent the corresponding actual pressures in atmospheres. According to the van't Hoff equation, $\pi = CRT$, the osmotic value ($\pi$) of any solution may be obtained from the concentration of the particles in solution ($C$), the gas constant ($R$), and the absolute temperature ($T$).[42] If the osmotic value is expressed in atmospheres, then $R$ has the value 0.08207. The osmotic values here used are all calculated for a temperature of 25° C. (298° Abs.), so that $T$ becomes 298, and the equation may be restated:

$$\pi = (298)\ (0.08207)C = 24.46\ C.$$

For substances which do not dissociate or polymerize or form hydrates in solution the concentration, $C$, corresponds to the volume-molecular concentration, $M$; and the osmotic pressure formula becomes: $\pi = 24.46\ M$. But for salts, such as potassium chloride, which dissociate in solution into ions, $C = iM$;

[42] The osmotic pressure equation here used must be understood to be only approximately true for solutions such as are dealt with in the present work. It really applies only to very *dilute solutions*. For a good discussion of osmotic pressure equations see Washburn, E. W., Principles of Physical Chemistry. New York (1915) 150–164. Also see Renner, O., Ueber die Berechnung des osmotischen Druckes, Biol. Centralbl. 32 (1912) 486–504.

in this equation $i$ is the van't Hoff coefficient (or "mole-number"), which may be defined as the quotient of the number of particles actually present in the solution, divided by the number that would be present in an equal volume-molecular concentration of a substance that is unmodified in solution. Consequently, for salts the osmotic pressure formula becomes: $\pi = 24.46\ iM$. For un-ionized substances $i$ is unity, and for ionized substances such as salts $i$ has a value greater than unity. The equation may be written in the form:

$$iM = \frac{\pi}{24.46}.$$

By substituting for $\pi$ in this equation each of the partial osmotic pressures from the second column of Table 3, the corresponding values of $iM$ were obtained, and these are given in the fourth column. They represent the osmotic concentrations which are necessary to give the corresponding partial osmotic pressures given in the second column.

TABLE 3.—*Data used in calculating the partial concentrations (column III) of potassium chloride required to give from 0.1 to 0.7 of the total osmotic concentration of 1.60 atmospheres, for series I.*

| I. Fractional parts of total concentration (1.60 atmospheres). | II. Partial osmotic pressures. | III. Volume-molecular concentration of KCl. | IV. Degree of ionization. | V. "Mole-number," or van't Hoff coefficient, $i$. | VI. Concentration calculated from $C=iM$. |
|---|---|---|---|---|---|
| | Atm. | *M.* | | | |
| | | [a]*0.0020* | [b]*0.971* | [c]1.971 | *0.0039* |
| 0.1 | 0.16 | 0.0033 | | | 0.0065 |
| | | *0.0050* | *0.956* | 1.956 | *0.0098* |
| 0.2 | 0.32 | 0.0067 | | | 0.0131 |
| | | *0.0100* | *0.941* | 1.941 | *0.0194* |
| 0.3 | 0.48 | 0.0101 | | | 0.0196 |
| 0.4 | 0.64 | 0.0135 | | | 0.0262 |
| 0.5 | 0.80 | 0.0170 | | | 0.0327 |
| | | *0.0200* | *0.922* | 1.922 | *0.0384* |
| 0.6 | 0.96 | 0.0205 | | | 0.0392 |
| 0.7 | 1.12 | 0.0240 | | | 0.0458 |
| | | *0.0500* | *0.889* | *1.889* | *0.0945* |

[a] The values in italics have been obtained from Noyes and Falk.
[b] From Noyes and Falk.
[c] This is the van't Hoff coefficient. It is obtained from the relation $i = 1 + (n-1)\ a$. For non-electrolytes its value is 1.

It was next necessary to calculate the volume-molecular concentrations ($M$) of potassium chloride that correspond to these values of $iM$. To do this an indirect method is required. If the degree of dissociation of a salt is known for a given volume-molecular concentration, $M$, the particulate concentration, $iM$, may be calculated by means of the equation:

$$iM = 1 + (n-1)\,\alpha M.$$

In this equation $n$ is the number of ions formed when a molecule of the salt is dissociated, and $\alpha$ (given just below) is the degree of ionization, or the fraction of the whole number of molecules that dissociates at a given concentration. For potassium chloride $n$ has a value of 2, and the equation becomes:

$$iM = (1 + \alpha)\,M.$$

Values for the degree of ionization $\alpha$ of potassium chloride were obtained from Noyes and Falk's compilation,[43] based upon determinations of the conductance ratio. The volume-molecular concentrations ($M$) and the corresponding values of $\alpha$ are the italicized values given in the third and fourth columns, respectively. The corresponding values of $iM$ for this salt, calculated by means of the last-mentioned formula, are the italicized values in the sixth column. Each of these italicized values in the sixth column represents the calculated osmotic concentration ($iM$), corresponding to a known volume-molecular concentration ($M$) of potassium chloride.

As has been explained, each of the values in roman type in the sixth column represents an osmotic concentration ($iM$) corresponding to an unknown volume-molecular concentration ($M$). These unknown values have been calculated by interpolation between the italicized values in the third column, assuming a linear relationship. The formula[44] used for this interpolation was the following:

$$M_0 = M_1 + [(iM)_0 - (iM)_1]\frac{M_2 - M_1}{(iM)_2 - (iM)_1}.$$

In this equation the two given values of $M$ are $M_1$ and $M_2$, the two given values of $iM$ are $(iM)_1$ and $(iM)_2$, and the values to be interpolated are $M_0$ and $(iM)_0$, the value for $(iM)_0$ being derived from the formula:

$$(iM)_0 = \frac{\pi}{RT}$$

as described above.

[43] Noyes, A. A., and Falk, K. G., The properties of salt solutions in relation to the ionic theory. III. Electrical conductance, Journ. Am. Chem. Soc. 34 (1912) 474 and 475.

[44] See Ashton, C. H., Analytic Geometry. New York (1908) 35.

The interpolated values thus obtained for $M_0$ are inserted in roman type in the third column of the same table, and each of these is taken as the volume-molecular concentration of potassium chloride required to produce the corresponding partial osmotic pressure given in the second column. It will be seen that only these interpolated values were actually employed in making up the solutions. These are the values given in the second column of Table 2.

Similar calculations were made for each of the other three salts. The degrees of dissociation for calcium nitrate and magnesium sulphate were taken from Noyes and Falk, while those for monopotassium phosphate were obtained from Abbott and Bray.[45] The data used in making the calculations for these three salts will not be given here, but the final interpolated values are given in the last three columns of Table 2.

Many of the solutions used in this set were subjected to freezing-point determinations by the Beckmann method, in the same way that Shive [46] tested the total concentrations of Tottingham's and his own solutions. It was found that the lowering of the freezing point ($\triangle$) for the solutions of this series varied from about 0.11° to 0.13°. Calculating the osmotic values corresponding to these limits, it appears that these values (for 25° C.) varied from about 1.50 to about 1.70 atmospheres.[47] The error in the osmotic value here introduced may be considered as negligible in this kind of work, for it will be recalled that those solutions were calculated to have an osmotic value of 1.60 atmospheres.

RESULTS OF SERIES I

*Appearance of plants.*—During the early part of the twenty-four-day period of series I most of the cultures were alike in appearance, although root development was noticeably retarded in some of the cultures as early as the time of the first renewal of solution. These injured cultures were the ones in solutions

[45] Abbott, G. A., and Bray, W. C., The ionization relations of ortho- and pyrophosphoric acids and their sodium salts, Journ. Am. Chem. Soc. 31 (1909) 729–763.

[46] Shive, J. W., The freezing points of Tottingham's nutrient solutions, Plant World 17 (1914) 345–353. Also, see Shive, J. W., Am. Journ. Bot. 2 (1915) 157–160.

[47] The following approximate formula was used for this calculation:

$$\pi\ 25° = \frac{298}{273}\ 12.06\ \triangle = 13.164\ \triangle.$$

having high partial concentrations of magnesium sulphate, especially cultures T1R1C1 and T2R1C1. Growth, however, did not cease in these injured cultures, for the plants continued to enlarge slowly throughout the period. The solutions containing less magnesium sulphate produced much better growth and gave the most healthy appearing plants when the series was discontinued. During the latter part of the period these better cultures were seen to have much longer lateral roots and their tops were lighter green in color and noticeably larger than in the injured cultures.

Rather pronounced differences in the color of the plants in different cultures were apparent at the time of harvesting. The color ranged from a very deep shade of green to a light yellowish green. The plants in the cultures along the left-hand margins of triangle 1 and triangle 2 (fig. 1) were darkest green, while those along the right-hand margins of triangles 4, 5, and 6, and the culture of triangle 7 were the most chlorotic. In general, the depth of green decreased in passing from left to right in the triangles and in passing in the tetrahedron from triangle 1 to triangle 7. The largest tops were intermediate in color. Another morphological difference that appeared was a drying and bleaching of the tissue between the main veins, in some cultures resulting in longitudinal stripping of the leaves. This condition was limited to the cultures in solutions with low monopotassium phosphate content, especially rows 1, 2, and 3 of triangles 1 and 2.

A very similar symptom was observed by Tottingham in several of his four-salt solutions having an osmotic concentration of 8.15 atmospheres. This symptom was found in cultures having a high content of monopotassium phosphate, a maximum content of potassium nitrate, and approximately equal contents of calcium nitrate and magnesium sulphate. A thickening of the base of the stem with branching from the same region (perhaps equivalent to the "stooling" of wheat in the field) appeared in those cultures where root injury was most pronounced. Such branching of the wheat plant occurs normally in the field when the plants are considerably older than these plants were. It is suggested that those solutions which were unfavorable to root development also brought about symptoms of an earlier maturation of the plant.

The most pronounced morphological modification of the leaves appeared to be similar to that described by Tottingham as magnesium injury; this modification was also observed by Shive.

This form of leaf injury, which appeared in a few of the plants after about twelve days in the culture solutions and in more of them at the time of harvest, was characteristic of those cultures whose solutions had high ratios of magnesium sulphate to calcium nitrate. The two degrees of this injury, described by Shive as severe and as slight, were observed in this series and their distribution on the diagram is shown in fig. 2. In recording the occurrence of these two degrees of injury, when a spiral coiling was formed or the whole leaf was affected, the injury was considered severe; when no spiral was formed and not the whole leaf was affected, the injury was considered slight. In fig. 2 the cultures marked with crosses showed severe injury, and those marked with circles slight injury. The number of leaves injured, in the entire culture of six plants, is shown by the numeral placed near the point of the diagram.

*Dry weights.*—Since the roots and tops were weighed separately, two dry-weight data were obtained for each culture. The sum of these two weights, of course, gives the total dry weight of the plants in the cultures, but since this sum is generally controlled in its variation by the dry weight of tops, only the separate data for tops and for roots will be considered.

These data are presented in Table 4, in which the first column gives the culture number; the second, the data for tops; and the third, the data for roots. The dry weights are expressed as relative numbers, in terms of the value for the highest actual dry weight considered as 100. The actual dry weight for this culture is given in parentheses below the value 100. The actual dry weights may be obtained by means of this value.

High yields are indicated in the table by the letter H and low by the letter L. The method of defining high and low yields is as follows: The twenty-one cultures (one-fourth of the total number) giving highest yields are marked H, and the twenty-one giving lowest values are marked L. The remaining forty-two cultures (half of the total number) are considered as medium, excepting those which are numerically the same as the lowest of the "high" group which are marked H, and those which are the same as the highest of the "low" group which are marked L. The highest yield obtained in the series is indicated by gothic type, and the lowest by italics. The average relative yields obtained with Shive's and with Tottingham's best solutions, employed as controls in this series, are given at the bottom of the table, for comparison.

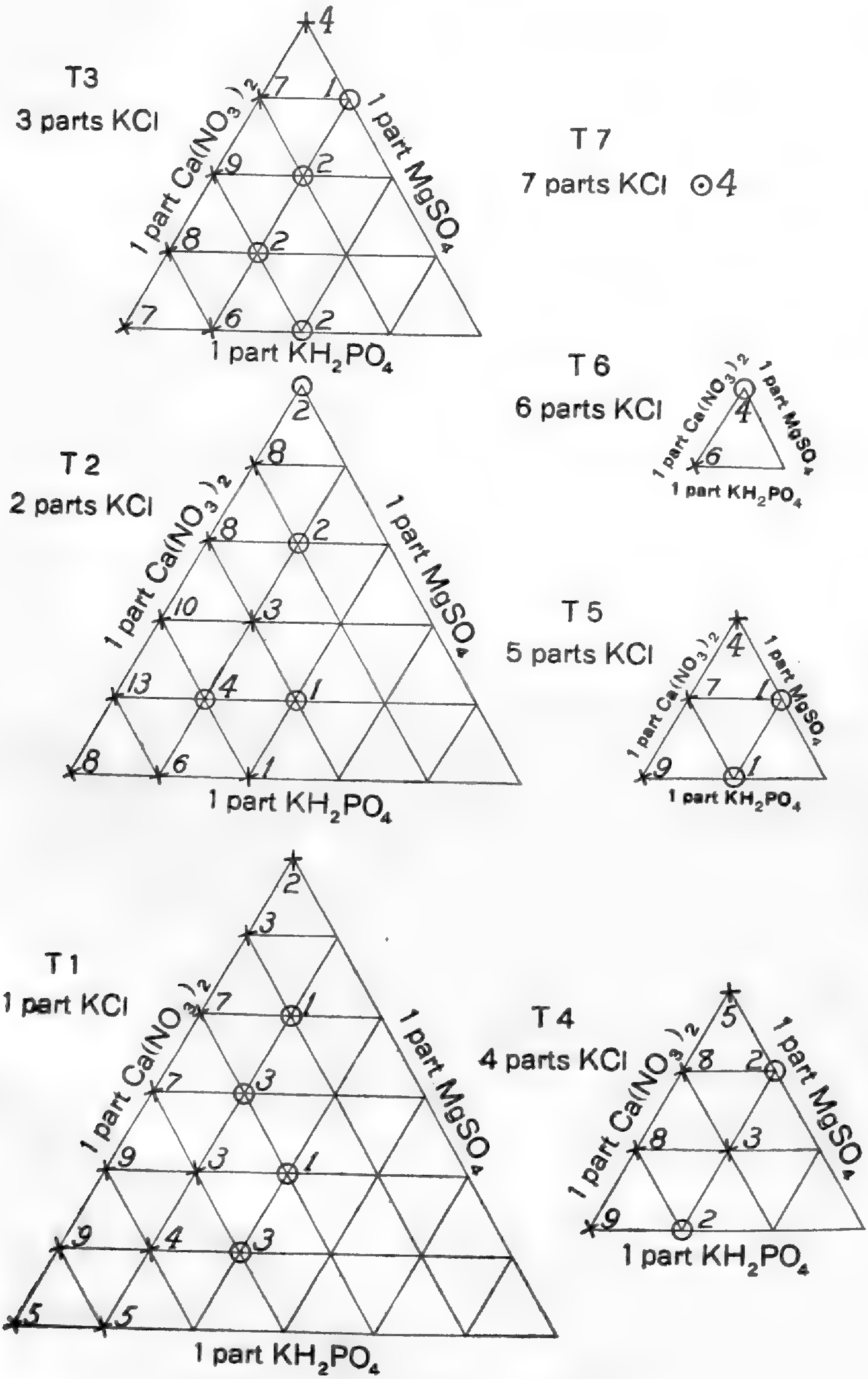


Fig. 2. Diagram for series I, showing leaf injury.

TABLE 4.—*Relative dry weights of tops and roots of wheat; also, water-absorption data, and the amount of water absorbed for each gram of yield of tops and of roots (water requirement), relative to the highest as 100; for series I, conducted from January 11 to February 4, 1916.*

| Culture No. | Dry weight. | | Water absorption. | Water requirement. | |
|---|---|---|---|---|---|
| | Tops (6 plants). | Roots (6 plants). | | Tops. | Roots. |
| T1R1C1 | *60L* | 60L | *58L* | 80L | *66L* |
| C2 | 71L | 63L | 82L | 94H | 88 |
| C3 | 85 | 70 | 97H | 94H | 95H |
| C4 | 70L | 58L | 83 | 98H | 98H |
| C5 | 80 | *54L* | 81L | 81L | 99H |
| C6 | 68L | 55L | 78L | 93H | 96H |
| C7 | 86 | 80H | 87 | 84 | 74L |
| R2C1 | 74L | 67 | 80L | 89 | 82 |
| C2 | 81 | 69 | 84 | 85 | 82 |
| C3 | 82 | 60L | 86 | 86 | 97H |
| C4 | 84 | 66 | 88 | 85 | 91H |
| C5 | 79 | 65L | 82L | 85 | 86 |
| C6 | 83 | 80H | 85 | 84 | 72L |
| R3C1 | 70L | 63L | 74L | 87 | 80 |
| C2 | 79 | 63L | 80L | 84 | 87 |
| C3 | 85 | 63L | 82L | 79L | 89H |
| C4 | 87H | 62L | 85 | 80L | 93H |
| C5 | 81 | 77 | 80L | 81L | 71L |
| R4C1 | 77L | 68 | 83 | 89 | 84 |
| C2 | 89H | 65L | 88 | 81L | 92H |
| C3 | 90H | 69 | 89 | 82L | 88 |
| C4 | 79 | 67 | 80L | 83 | 81 |
| R5C1 | 77L | 65L | 83 | 89 | 87 |
| C2 | 93H | 66 | 89 | *78L* | 92H |
| C3 | 88H | 76 | 90 | 83 | 81 |
| R6C1 | 84 | 65L | 85 | 82L | 90H |
| C2 | 89H | 66 | 89 | 82L | 92H |
| R7C1 | 83 | 56L | 80L | 79L | 98H |
| T2R1C1 | 71L | 74 | 76L | 88 | 71L |
| C2 | 72L | 56L | 74L | 84 | 90H |
| C3 | 80 | 57L | 83 | 85 | 100H (2058) |
| C4 | 78 | 67 | 93H | 98H | 95H |
| C5 | 86 | 74 | 94H | 90 | 88 |
| C6 | 81 | 69 | 83 | 85 | 83 |
| R2C1 | 74L | 66 | 80L | 89 | 83 |
| C2 | 85 | 61L | 81L | *78L* | 91H |
| C3 | 93H | 75 | 97H | 85 | 88 |
| C4 | 88H | 69 | 90 | 84 | 88 |
| C5 | 85 | 78H | 88 | 85 | 77L |
| R3C1 | 76L | 65L | 80L | 87 | 84 |
| C2 | 88H | 65L | 86 | 80L | 90H |
| C3 | 87H | 59L | 83 | 79L | 97H |
| C4 | 93H | 85H | 92H | 82L | 74L |
| R4C1 | 77L | 62L | 81L | 87 | 89H |
| C2 | 100H | 80H | 100H | 82L | 85 |

TABLE 4.—*Relative dry weights of tops and roots of wheat; also, water-absorption data, and the amount of water absorbed for each gram of yield of tops and of roots (water requirement), relative to the highest as 100; for series I, conducted from January 11 to February 4, 1916*—Continued.

| Culture No. | Dry weight. | | Water absorption. | Water requirement. | |
|---|---|---|---|---|---|
| | Tops (6 plants). | Roots (6 plants). | | Tops. | Roots. |
| | (.761) | | 344) | | |
| T2R4C3 | 94H | 85H | 89 | *78L* | 72L |
| R5C1 | 82 | 70 | 87 | 87 | 85 |
| C2 | 82 | 67 | 86 | 87 | 88 |
| R6C1 | 94H | 72 | 94H | 82L | 89H |
| T3R1C1 | 69L | 72 | 80L | 95H | 75L |
| C2 | 75L | 67 | 85 | 92H | 86 |
| C3 | 84 | 73 | 95H | 93H | 90H |
| C4 | 82 | 80H | 96H | 96H | 82 |
| C5 | 85 | 84H | 95H | 93H | 77L |
| R2C1 | 77L | 70 | 82L | 88 | 80 |
| C2 | 81 | 71 | 88 | 89 | 85 |
| C3 | 86 | 67 | 89 | 85 | 90H |
| C4 | 80 | 79H | 90 | 92H | 77L |
| R3C1 | 88 | 81H | 92H | 91 | 78L |
| C2 | 90H | 74 | 92H | 85 | 85 |
| C3 | 96H | 100H | 100H | 86 | 68L |
| | | (.245) | (344) | | |
| R4C1 | 79 | 70 | 89 | 93H | 87 |
| C2 | 94H | 85H | 92H | 81 | 74L |
| R5C1 | 82 | 70 | 86 | 87 | 84 |
| T4R1C1 | 68L | 68 | 80L | 97H | 80 |
| C2 | 81 | 78H | 92H | 93H | 81 |
| C3 | 84 | 74 | 98H | 96H | 91H |
| C4 | 81 | 72 | 89 | 90 | 84 |
| R2C1 | 80 | 80H | 87 | 90 | 74L |
| C2 | 88H | 70 | 88 | 82L | 85 |
| C3 | 87H | 80H | 98H | 87 | 80 |
| R3C1 | 89H | 83H | 94H | 87 | 77L |
| C2 | 91H | 78H | 90 | 81L | 78L |
| R4C1 | 91H | 82H | 98H | 89 | 81 |
| T5R1C1 | 78 | 82H | 93H | 99H | 77L |
| C2 | 80 | 73 | 93H | 95H | 87 |
| C3 | 82 | 84H | 96H | 96H | 78L |
| R2C1 | 70L | 69 | 79L | 92H | 79 |
| C2 | 84 | 75 | 92H | 90 | 83 |
| R3C1 | 87H | 85H | 97H | 92H | 78L |
| T6R1C1 | 68L | 73 | 82L | 100H | 77L |
| | | | | (550) | |
| C2 | 82 | 80H | 95H | 95H | 81 |
| R2C1 | 74L | 74 | 81L | 90 | 75L |
| T7R1C1 | 71L | 69L | 82L | 95H | 82 |
| Shive | 90H | 67L | 90 | | |
| Tottingham | 94H | 89H | 98H | | |

The yield data of Table 4 are presented graphically in fig. 1 (tops) and fig. 3 (roots). On these diagrams areas of high yields (H) are marked with small crosses, and those of low yields (L) are marked with small circles. The highest value in each case is shown by a large cross, and the lowest, by a large circle.

*Water absorption.*—The total amount of water absorbed by each culture was obtained by adding together the partial quantities recorded at the several changes of the solution. The sums thus obtained (relative to the greatest one) are shown in the fourth column of Table 4. Following the method employed for dry-weight data, the cultures giving high and low values are indicated by the letters H and L, respectively. The highest water-absorption value is indicated by gothic type and the lowest by italics.

*Water requirement.*—The amounts of water absorbed per unit of dry weight of tops and of roots were calculated for each culture. This ratio value is practically what has been termed the water requirement, and this term will be employed in this paper.[48] The last two columns of Table 4 present these data. The letters H and L are employed as heretofore, the highest value being again indicated by gothic type and the lowest by italics.

## DISCUSSION OF SERIES I

*Appearance of plants.*—As has been mentioned, the plants appeared greener in color with solutions having higher partial concentrations of magnesium sulphate, which suggests a direct relation between the color and the amount of magnesium present in the cells. Furthermore, the color was more intense in the cultures having low partial concentrations of potassium chloride, or in those cultures in which the other three salts were present in relatively large amounts. The cultures with high partial concentrations of potassium chloride may be considered as those in which the plants were deprived in a large measure of the essential elements, excepting potassium.

Striping of the leaves occurred, as already described, with solutions having comparatively low potassium chloride values and very low monopotassium phosphate values.

[48] Briggs, L. J., and Shantz, H. L., The water-requirement of plants., II. A review of the literature, Bull. U. S. Dept. Agric., Bur. Pl. Ind. (1913) 285. Since practically all the water absorbed by such plants as those of the present experiments is given off by transpiration, the water-absorption data represent total transpiration.

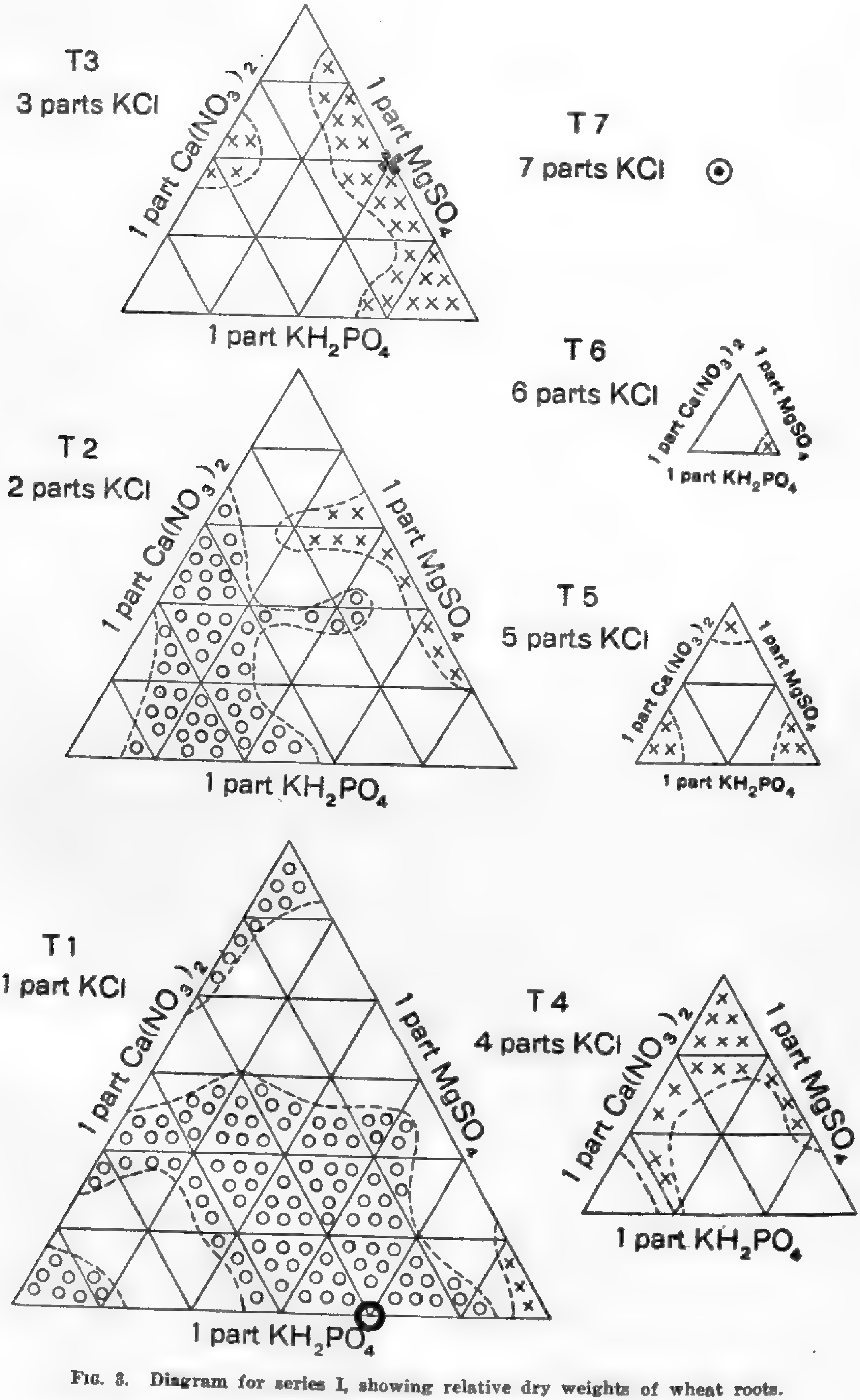


FIG. 3. Diagram for series I, showing relative dry weights of wheat roots.

Severe magnesium injury, pronounced root modifications, and the phenomenon resembling "stooling" were all clearly confined to solutions in which the ratio of magnesium to calcium lay between the limits 1.65 and 13.43; that is, in which the amount of magnesium sulphate was relatively high as compared with the amount of calcium nitrate. Of the remaining solutions, those in which the Mg/Ca-ratio value lay between the limits 0.81 and 3.64 showed slight magnesium injury. This form of injury in general was confined to the range of the ratio values from 0.81 to 13.43, and entire freedom from injury was shown in the cultures which had ratio values within the very narrow range from 0.21 to 0.81.

Shive found that when his three-salt solution had an osmotic value of 1.75 atmospheres the plants were free from magnesium injury with Mg/Ca-values of less than 1.5; and when the osmotic value was 4.00 atmospheres this limit occurred with the ratio value 2.2. From Tottingham's data it appears that no injury occurred with ratio values below 0.40, when the total osmotic value was 2.50 atmospheres; or below 0.28, when that value was approximately 8.00 atmospheres. This limiting value of the ratio Mg/Ca is thus seen to vary considerably according to the kinds of salts used, the salt proportions, and the total concentration of the solution. It may be added, however, that no case has been observed in the experimental studies here considered in which freedom from magnesium injury occurred with a ratio having a higher value than 2.90, except with solutions of very low total concentration where, Shive and Tottingham agree, none of this injury occurs at all with any value of this ratio.

*Dry weights.*—Inspection of the tetrahedral diagram of fig. 1 shows that the highest dry yield of tops was obtained in culture T2R4C2, having volume-molecular partial concentrations of the four salts as follows: 0.0067 M potassium chloride, 0.0138 M monopotassium phosphate, 0.0047 M calcium nitrate, and 0.0081 M magnesium sulphate. Lowest dry yield of tops (60 per cent of the highest) occurred in culture T1R1C1, having volume-molecular partial concentrations of the salts as follows: 0.0033 M potassium chloride; 0.0033 M monopotassium phosphate; 0.0023 M calcium nitrate; and 0.0309 M magnesium sulphate. The areas of low yields of tops occur in all triangles along the left-hand margins, corresponding to regions characterized by low partial concentrations of calcium nitrate and high partial concentrations of magnesium sulphate.

The highest actual dry weights of tops obtained from these twenty-four-day cultures was 0.761 gram, and the lowest was 0.457 gram. The average dry yields of tops from three cultures each of Shive's and Tottingham's best solutions for wheat were 0.684 and 0.714 gram, respectively. It, therefore, appears that all three of these best solutions may be expected to give about the same yield of tops for wheat plants of this variety grown for twenty-four days under the general aërial conditions met with in the present series.

A few other points bearing on the top yields of this series will be mentioned in the discussion of series II.

With reference to root yields, the maximum dry weight was obtained in culture T3R3C3. In a general way, the areas of high and low root yields on the diagram (fig. 3) agree with the corresponding areas for top yields (fig. 1). The general truth of this statement is especially worthy of emphasis, because its opposite was true for the series of Shive and of Tottingham. It is possible that the addition of potassium chloride to the Shive three-salt solution resulted in altering in a fundamental way the relation between top yields and root yields.

*Water absorption.*—Greatest water absorption occurred with two cultures, T2R4C2, which also gave highest top yields, and culture T3R3C3, the latter culture having the following partial concentrations: 0.0101 M potassium chloride, 0.0103 M monopotassium phosphate, 0.0072 M calcium nitrate, and 0.0038 M magnesium sulphate. The lowest amount of water absorption occurred in culture T1R1C1, which also gave the lowest top yield and very low root yields. This very small water absorption appears undoubtedly related to the stunted tops and poor root development previously mentioned.

Triangular diagrams for water absorption (which is practically a measure of transpiration) have been omitted in the publication of this paper. But a comparison of such diagrams with those of figs. 1 and 3 (dry weights of tops and of roots, respectively) has shown that, in a very general way, the regions for high absorption correspond to those for high top and high root yields, all three occupying the areas of the triangles characterized by medium proportions of calcium and magnesium, and medium and low proportions of potassium chloride. This comparison has also shown that the areas of low water absorption generally correspond to areas of low top and root yields.

these low areas lying in the lower left-hand corners of the triangles, denoting solutions having high proportions of magnesium sulphate, and low proportions of calcium nitrate and monopotassium phosphate. The general proportionality between the transpiration and the dry yield reported by other workers was thus observed in these experiments. This relation is of course to be expected, since the ability of a particular set of plants to transpire depends principally upon the leaf surface of the plants; this is measured approximately by their dry weight, and the amount of water absorbed is a measure of their transpiration.[49]

*Water requirement.*—The highest water requirement for tops (Table 4) was found to be that for culture T6R1C1, having 0.6 of its total osmotic concentration due to potassium chloride. Three quite different cultures showed the lowest water requirement for tops. These were cultures T1R5C2, T2R2C2, and T2R4C3. There is very little in common between these cultures, as regards the proportions of the salts. Triangular diagrams, omitted in this publication, have shown that areas of high water requirements for tops occur in all of the triangles; that is, with all proportions of potassium chloride tested. These areas lie in almost all cases along the lower margins of the triangles, and are thus restricted to cultures having very low partial concentrations of monopotassium phosphate. On the other hand, low water requirements are in general associated with high relative proportions of monopotassium phosphate. In a very general way, solutions which gave high water requirements of tops also gave high top yields and, conversely, those which gave low water requirements gave low top yields. No relation is apparent between high water requirement of tops and either water absorption or root yields.

Turning now to water requirement of roots, it is seen that culture T2R1C3 showed the highest value, while culture T1R1C1 showed the lowest value. High values were not found in this series for solutions having more than 0.4 of their total concentration due to potassium chloride. There is no evident general correlation between either high or low values and the proportions of the various nutrient salts. A comparison of the triangular diagrams, representing water requirement of roots, with fig. 3 has shown that there is a suggestion of an inverse relationship

[49] Livingston, B. E., Relation of transpiration to growth in wheat, Bot. Gaz. 40 (1905) 178–195.

between the water requirement of roots and the dry weight of roots. Likewise, there is, in the present results, a tendency for the water requirement of roots to be inversely related to water absorption. There appears to be little or no relationship between the water requirement of roots and either the dry weight or the water requirement of tops.

## SERIES II

### METHODS OF SERIES II

This series was conducted for twenty-four days, from February 12 to March 7, 1916. The highest temperature recorded during this period was 28° C. (February 14, 22, 28) and the lowest was 10° C. (February 13). The average daily maximum temperature for the period was 25°, and the average daily minimum was 16° C. The corrected water loss from the spherical porous-cup atmometer showed a daily mean of 17.5 cubic centimeters and a total loss of 241 cubic centimeters for the entire period. This series was carried out in duplicate, so that there were two simultaneous cultures of six plants each for each of the sets of salt proportions tested.

The plan of this series was similar to that followed for series I. The same four salts were employed and the solutions also had the same total osmotic concentration (1.60 atmospheres) as before. In series II it was planned to cover the range of salt proportions used in series I without repeating all of the cultures. Forty selected solutions were used. Their composition may be represented by the same kind of diagrams as were used for series I. The numbers and positions upon the diagram of these selected solutions are shown in fig. 4, the culture solutions here used being represented by dots. It will be seen that solutions from all of the triangles are included. The method of designation is the same as in series I, but fractional numbers must be used to designate solutions which do not fall upon the points of intersection of the lines. In solution T2R4$\frac{2}{3}$C1$\frac{2}{3}$, for example, the four salts contribute the following portions of the total osmotic concentration: Potassium chloride, 0.2; monopotassium phosphate, 0.4$\frac{2}{3}$; calcium nitrate, 0.1$\frac{2}{3}$; and magnesium sulphate, 0.1$\frac{2}{3}$. For comparison, Shive's best three-salt solution for wheat and Tottingham's best four-salt solution were again used.

**Table 5.**—*Partial concentrations of potassium chloride, monopotassium phosphate, calcium nitrate, and magnesium sulphate in each of the solutions employed in series II; also, the values of the three cation ratios; total osmotic value of each solution, 1.60 atmospheres.*

| Culture No. | Volume-molecular concentration. | | | | Cation-ratio value. | | |
|---|---|---|---|---|---|---|---|
| | KCl. | $KH_2PO_4$. | $Ca(NO_3)_2$ | $MgSO_4$. | Mg/Ca. | Mg/K. | Ca/K. |
| | *M.* | *M.* | *M.* | *M.* | | | |
| T1R1C1 | 0.0033 | 0.0033 | 0.0023 | 0.0309 | 13.43 | 4.68 | 0.35 |
| T1R1C4 | 0.0033 | 0.0033 | 0.0098 | 0.0171 | 1.75 | 2.59 | 1.48 |
| T1R1C7 | 0.0033 | 0.0033 | 0.0117 | 0.0038 | 0.21 | 0.58 | 2.68 |
| T1R2C2 | 0.0033 | 0.0068 | 0.0047 | 0.0216 | 4.60 | 2.14 | 0.47 |
| T1R2C5 | 0.0033 | 0.0068 | 0.0124 | 0.0081 | 0.65 | 0.80 | 1.23 |
| T1R3C3 | 0.0033 | 0.0103 | 0.0072 | 0.0126 | 1.75 | 0.93 | 0.53 |
| T1R4C1 | 0.0033 | 0.0138 | 0.0023 | 0.0171 | 7.44 | 1.00 | 0.13 |
| T1R4C4 | 0.0033 | 0.0138 | 0.0098 | 0.0038 | 0.39 | 0.22 | 0.57 |
| T1R5C2 | 0.0033 | 0.0172 | 0.0047 | 0.0081 | 1.72 | 0.39 | 0.23 |
| T1R7C1 | 0.0033 | 0.0243 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T2R1C1 | 0.0067 | 0.0033 | 0.0023 | 0.0261 | 11.35 | 2.61 | 0.23 |
| T2R1C3½ | 0.0067 | 0.0033 | 0.0085 | 0.0149 | 1.75 | 1.49 | 0.85 |
| T2R1C6 | 0.0067 | 0.0033 | 0.0150 | 0.0038 | 0.25 | 0.38 | 1.50 |
| T2R1⅔C1⅔ | 0.0067 | 0.0056 | 0.0039 | 0.0201 | 5.15 | 1.63 | 0.32 |
| T2R1⅔C4⅔ | 0.0067 | 0.0056 | 0.0115 | 0.0067 | 0.58 | 0.54 | 0.93 |
| T2R2⅔C2⅔ | 0.0067 | 0.0091 | 0.0064 | 0.0111 | 1.73 | 0.70 | 0.41 |
| T2R3½C1 | 0.0067 | 0.0121 | 0.0023 | 0.0149 | 6.48 | 0.79 | 0.12 |
| T2R3½C3½ | 0.0067 | 0.0121 | 0.0085 | 0.0038 | 0.45 | 0.20 | 0.45 |
| T2R4⅔C1⅔ | 0.0067 | 0.0161 | 0.0039 | 0.0067 | 1.72 | 0.29 | 0.17 |
| T2R6C1 | 0.0067 | 0.0208 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T3R1C1 | 0.0101 | 0.0033 | 0.0023 | 0.0216 | 9.39 | 1.61 | 0.17 |
| T3R1C3 | 0.0101 | 0.0033 | 0.0072 | 0.0126 | 1.75 | 0.94 | 0.54 |
| T3R1C5 | 0.0101 | 0.0033 | 0.0124 | 0.0038 | 0.31 | 0.28 | 0.93 |
| T3R1⅔C1⅔ | 0.0101 | 0.0056 | 0.0039 | 0.0156 | 4.00 | 0.99 | 0.25 |
| T3R1⅔C3⅔ | 0.0101 | 0.0056 | 0.0089 | 0.0067 | 0.75 | 0.43 | 0.57 |
| T3R2⅓C2⅓ | 0.0101 | 0.0080 | 0.0055 | 0.0096 | 1.75 | 0.53 | 0.30 |
| T3R3C1 | 0.0101 | 0.0103 | 0.0023 | 0.0126 | 5.48 | 0.62 | 0.11 |
| T3R3C3 | 0.0101 | 0.0103 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| T3R3⅔C1⅔ | 0.0101 | 0.0126 | 0.0039 | 0.0067 | 1.72 | 0.30 | 0.17 |
| T3R5C1 | 0.0101 | 0.0173 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T4R1C1 | 0.0135 | 0.0033 | 0.0023 | 0.0171 | 7.44 | 1.02 | 0.14 |
| T4R1C4 | 0.0135 | 0.0033 | 0.0098 | 0.0038 | 0.39 | 0.23 | 0.58 |
| T4R2C2 | 0.0135 | 0.0068 | 0.0047 | 0.0081 | 1.72 | 0.40 | 0.23 |
| T4R4C1 | 0.0135 | 0.0138 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T5R1C1 | 0.0170 | 0.0033 | 0.0023 | 0.0126 | 5.48 | 0.62 | 0.11 |
| T5R1C3 | 0.0170 | 0.0033 | 0.0072 | 0.0038 | 0.53 | 0.19 | 0.35 |
| T5R1⅔C1⅔ | 0.0170 | 0.0056 | 0.0039 | 0.0067 | 1.72 | 0.30 | 0.17 |
| T5R3C1 | 0.0170 | 0.0103 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |
| T6R1⅓C1⅓ | 0.0205 | 0.0045 | 0.0031 | 0.0052 | 1.68 | 0.21 | 0.12 |
| T7R1C1 | 0.0240 | 0.0033 | 0.0023 | 0.0038 | 1.65 | 0.14 | 0.08 |

The chemical composition of each of the forty solutions in series II is shown in Table 5, which corresponds in arrangement to Table 1. The calculation for this series followed the general method employed in series I and resulted in the partial molecular concentrations given in Table 6, which were used directly in the preparation of Table 5.

TABLE 6.—*Partial concentration of each of the four salts required to produce from 0.1 to 0.7 of the total osmotic concentration of 1.60 atmospheres; for series II.*

| Fractional parts of 1.60 atmospheres. | Salt. | | | |
|---|---|---|---|---|
| | KCl. | $KH_2PO_4$. | $Ca(NO_3)_2$. | $MgSO_4$. |
| | *M.* | *M.* | *M.* | *M.* |
| 0.1 | 0.0033 | 0.0033 | 0.0023 | 0.0038 |
| 0.1⅓ | ------------ | 0.0045 | 0.0031 | 0.0052 |
| 0.1⅔ | ------------ | 0.0056 | 0.0039 | 0.0067 |
| 0.2 | 0.0067 | 0.0068 | 0.0047 | 0.0081 |
| 0.2⅓ | ------------ | 0.0080 | 0.0055 | 0.0096 |
| 0.2⅔ | ------------ | 0.0091 | 0.0064 | 0.0111 |
| 0.3 | 0.0101 | 0.0103 | 0.0072 | 0.0126 |
| 0.3½ | ------------ | 0.0121 | 0.0085 | 0.0149 |
| 0.3¾ | ------------ | 0.0126 | 0.0089 | 0.0156 |
| 0.4 | 0.0135 | 0.0138 | 0.0098 | 0.0171 |
| 0.4⅔ | ------------ | 0.0161 | 0.0115 | 0.0201 |
| 0.5 | 0.0170 | 0.0173 | 0.0124 | 0.0216 |
| 0.6 | 0.0205 | 0.0208 | 0.0150 | 0.0261 |
| 0.7 | 0.0240 | 0.0243 | 0.0177 | 0.0309 |

## RESULTS OF SERIES II

*Appearance of plants.*—Root and top development took place in a way very similar to that described for the preceding series. The various differences in the appearance of the plants described as occurring in series I were observed in the present series to about the same degree with reference to the range of salt proportions. The distribution of the two forms of magnesium injury in this series is shown by the diagrams of fig. 5, which is to be interpreted like fig. 2.

*Dry weights.*—The dry weight data for this series are shown in Table 7, in which the various items are arranged as in Table 4, excepting that in the present case the actual values corresponding to the two duplicate cultures are given, followed by the relative average. Thus these relative average weights correspond to the relative weights given in Table 4. The letters H and L are used in the same way as in the preceding series, but it will of course be noted that the "high" and the "low"

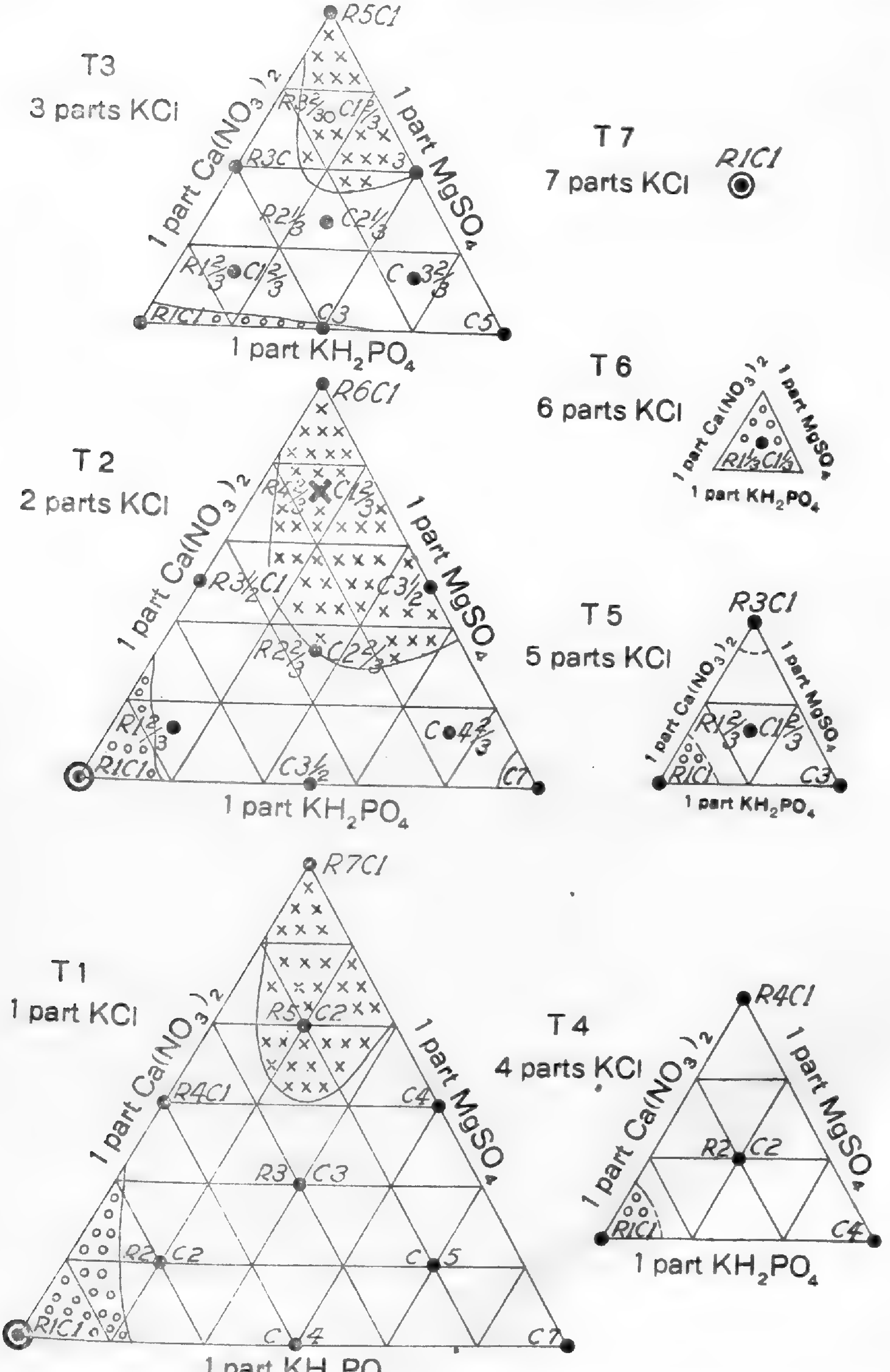


FIG. 4. Diagram for series II, showing culture numbers and osmotic proportions of the four salts.

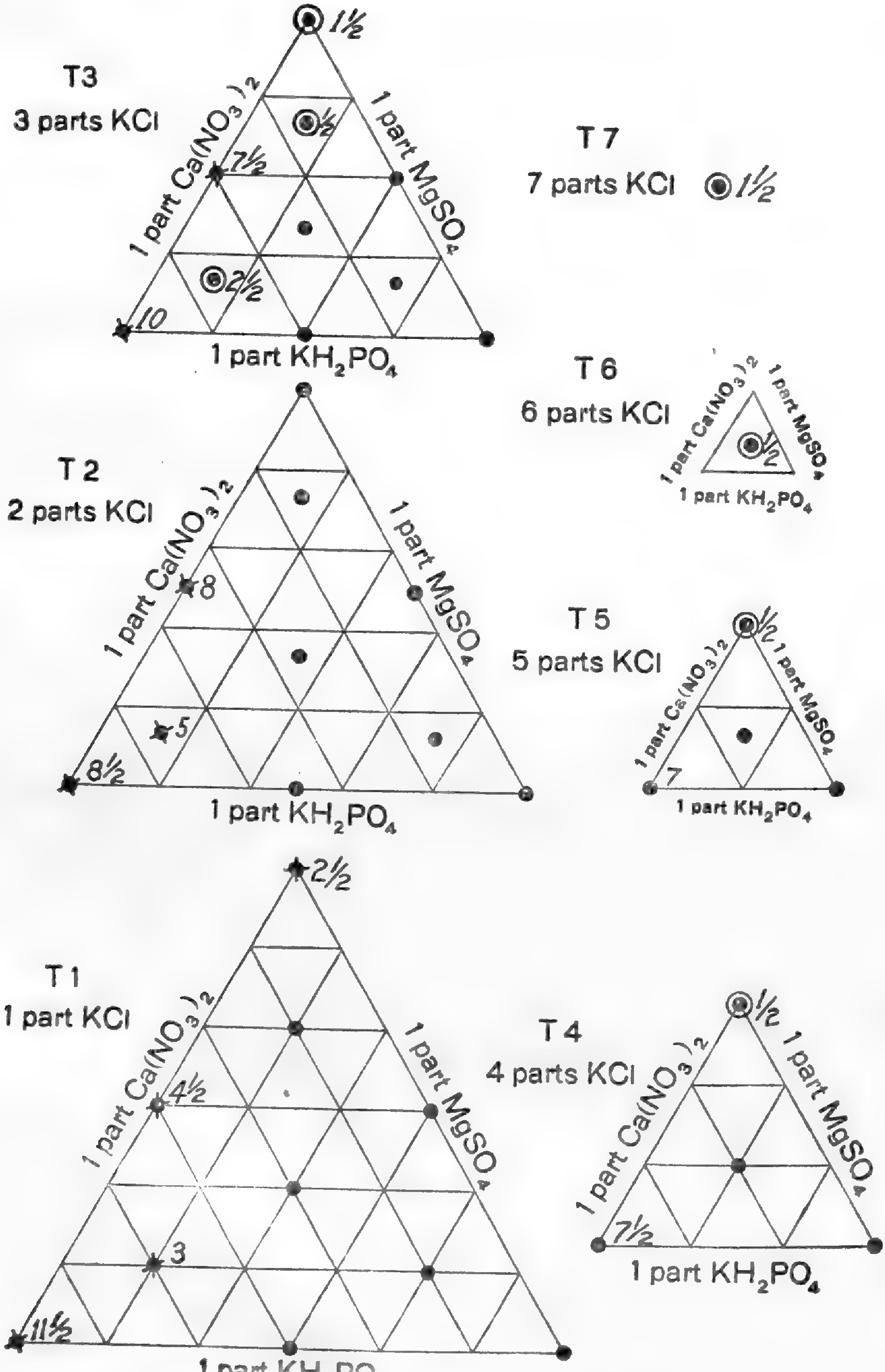


FIG. 5. Diagram for series II, showing leaf injury.

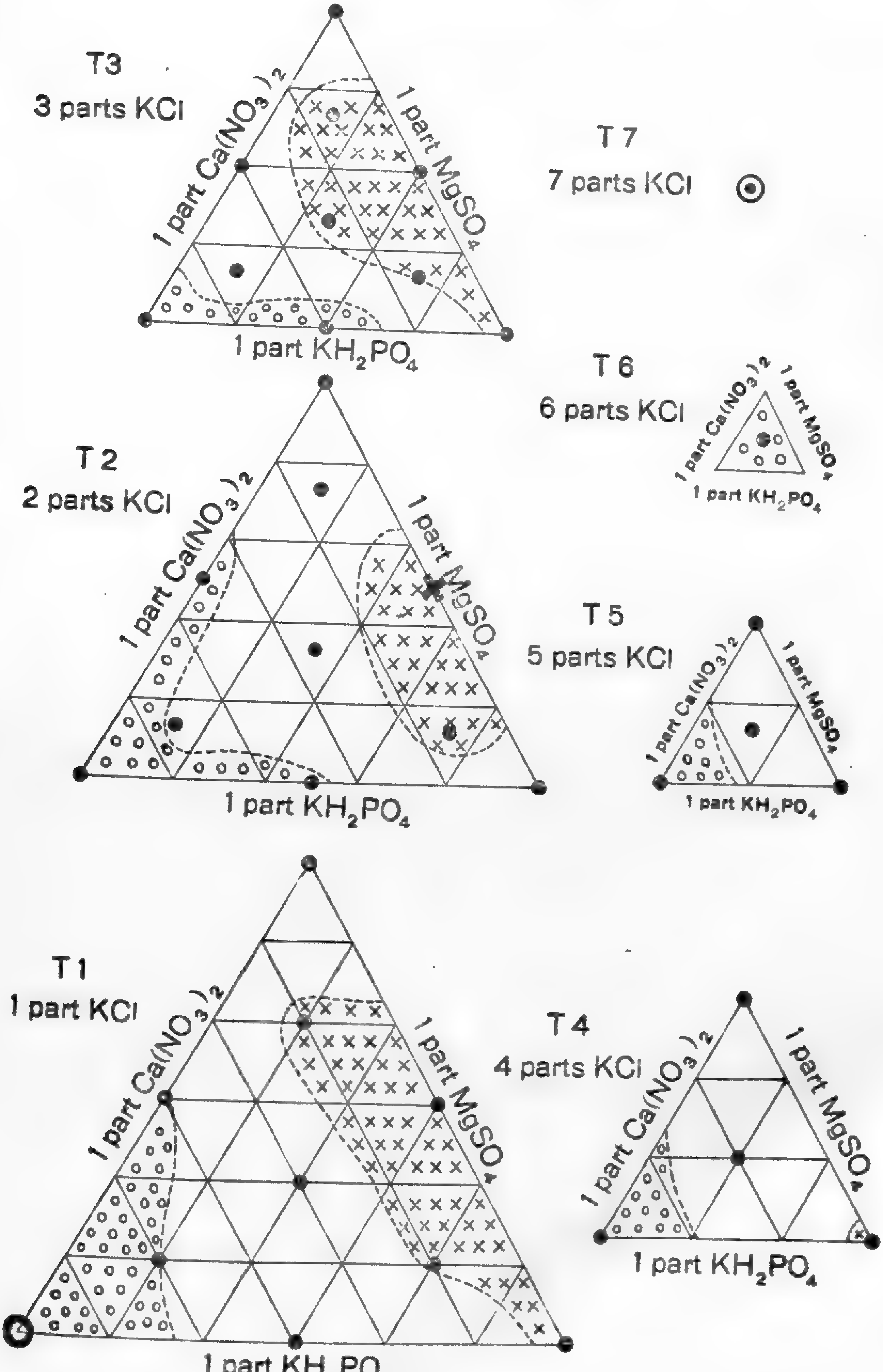


FIG. 6. Diagram for series II, showing relative dry weights of wheat roots.

groups here primarily include ten cultures each, instead of twenty-one as in the other case. The relative average yields simultaneously obtained with Shive's and with Tottingham's best solutions are again given at the bottom of the table. The data of Table 7 are shown diagrammatically in fig. 4 (tops) and fig. 6 (roots), in which the method of plotting is the same as that for series I (figs. 1 and 3.)

*Water absorption.*—The data of the total water absorption for each of the cultures in this series are shown in Table 8, where arrangement and notation are the same as heretofore followed.

*Water requirement.*—The relative average values for the amounts of water absorbed per unit of dry weight of tops and of roots are also presented in Table 8.

### DISCUSSION OF SERIES II

*Appearance of plants.*—The appearance of the plants and the occurrence of magnesium injury were practically the same as in series I, and these features need not be discussed in detail.

*Dry weights.*—The distribution of the high and low values of top yields on the diagram for this series (fig. 4) agrees in general with the distribution of these values for series I (fig. 1). The highest yields of tops for series II was 0.804 gram for culture T2R4$\frac{2}{3}$C1$\frac{2}{3}$, which had virtually the same salt proportions as the one giving the highest yield in series I (T2R4C2). Culture T1R1C1 gave the lowest top yield in series I and in both the duplicates of series II. The lowest yields for the two duplicates of series II were 0.573 and 0.529 gram (an average of 69 per cent of the highest), while the corresponding lowest yield for series I (carried out earlier in the winter) was 0.457 gram. In a similar way, the two duplicates giving the highest yield in series II (culture T2R4$\frac{2}{3}$C1$\frac{2}{3}$) were 0.804 and 0.803 gram, while the highest yield from series I (culture T2R4C2) was 0.761 gram. This suggests that the aërial conditions for the two series were such as to give a somewhat higher yield of tops in the second series. The average top yield for four parallel cultures of Shive's best solution was 0.801 gram, practically the same as the best yield from the series with chloride. This value was also markedly higher than the corresponding value (0.684 gram) for the Shive solution in series I. A similar, though less pronounced, difference between the average top yields for Tottingham's solution in series I (0.714 gram) and in series II (0.751 gram) may be noticed. As far as these data go, it appears that Tottingham's best solution gave a somewhat higher top yield than did Shive's in series I, while this relation was reversed in series II. On the whole, however, the best three salt proportions seem to be about the same in their ability to produce dry top yields under the aërial conditions of both these series.

As has been said, the salts used in the present study are the same as those of the solution that has come to be known as Detmer's solution.[50] This contains the four salts in the following proportions: 0.0130 M calcium nitrate, 0.0039 M monopotassium phosphate, 0.0044 M magnesium sulphate, and 0.0072 M potassium chloride. These exact proportions were not tested in the present work, but there were two solutions, in both series I and series II, the proportions of which closely resembled those used by Detmer. These were T2R1C6 and T3R1C5. These two solutions resembling Detmer's gave only 81 and 85 per cent of the top yield obtained with the best proportions in series I (solution T2R4C2); and these same solutions gave only 77 and 81 per cent of the top yields obtained with the best proportions in series II (solution T2R4$\frac{3}{8}$C1$\frac{3}{8}$). In series I, at least thirty of the eighty-four solutions tested gave higher yields of tops than were obtained with the solutions closely resembling Detmer's in salt proportions. An even more marked improvement over the growth obtained with Detmer's exact proportions is reported by Shive for his best three-salt solution which, as has been mentioned, gave practically the same yield as did the best four-salt solution used in this study.

Regarding the production of root yields, the same generalizations appear to hold for series II as were stated for series I; and the general correspondence between high and low root areas, on the one hand, and between high and low top areas, on the other hand, seems to be more definite in the latter series. The salt proportions giving the lowest root yields were the same in both series (T1R1C1), and these same proportions also gave lowest top yields in both. In series II the highest root yield occurred in culture T2R3$\frac{1}{2}$C3$\frac{1}{2}$, which had nearly the same salt proportions as the culture giving highest root yields in series I (T3R3C3).

[50] Detmer, W., Practical Plant Physiology. Translated by S. A. Moor. London (1898) 2.

TABLE 7.—*Actual and relative average dry weights of tops and roots of wheat; for series II, conducted from February 12 to March 7, 1916.*

| Culture No. | Tops (6 plants). | | | Roots (6 plants). | | |
|---|---|---|---|---|---|---|
| | A, actual. | B, actual. | Average, relative. | A, actual. | B, actual. | Average, relative. |
| T1R1C1 | 0.573 | 0.529 | *69 L* | 0.175 | 0.176 | *56 L* |
| T1R1C4 | 0.699 | 0.658 | 84 | 0.244 | 0.218 | 74 |
| T1R1C7 | 0.586 | 0.621 | 75 L | 0.264 | 0.307 | 91H |
| T1R2C2 | 0.728 | 0.685 | 88 | 0.223 | 0.212 | 69 L |
| T1R2C5 | 0.690 | 0.644 | 83 | 0.283 | 0.217 | 80H |
| T1R3C3 | 0.732 | 0.733 | 91 | 0.224 | 0.231 | 73 |
| T1R4C1 | 0.710 | 0.673 | 86 | 0.221 | 0.213 | 69 L |
| T1R4C4 | 0.667 | 0.748 | 88 | 0.256 | 0.305 | 89H |
| T1R5C2 | 0.783 | 0.735 | 94H | 0.269 | 0.238 | 81H |
| T1R7C1 | 0.780 | 0.772 | 97H | 0.256 | 0.225 | 77 |
| T2R1C1 | 0.522 | 0.582 | *69 L* | 0.187 | 0.180 | 59 L |
| T2R1C3½ | 0.628 | 0.663 | 80 | 0.203 | 0.210 | 66 L |
| T2R1C6 | 0.631 | 0.608 | 77 L | 0.237 | 0.244 | 77 |
| T2R1½C1½ | 0.689 | 0.670 | 85 | 0.212 | 0.237 | 72 |
| T2R1½C4½ | 0.682 | 0.699 | 86 | 0.248 | 0.275 | 83H |
| T2R2½C2½ | 0.744 | 0.738 | 92H | 0.231 | 0.242 | 75 |
| T2R3½C1 | 0.655 | 0.683 | 83 | 0.203 | 0.224 | 68 L |
| T2R3½C3½ | 0.741 | 0.782 | 95H | 0.305 | 0.323 | 100H (.314) |
| T2R4½C1½ | 0.804 | 0.808 | 100H (.804) | 0.230 | 0.234 | 74 |
| T2R6C1 | 0.756 | 0.803 | 97H | 0.222 | 0.243 | 74 |
| T3R1C1 | 0.601 | 0.632 | 77 L | 0.209 | 0.221 | 68 L |
| T3R1C3 | 0.615 | 0.605 | 76 L | 0.212 | 0.209 | 67 L |
| T3R1C5 | 0.635 | 0.661 | 81 | 0.287 | 0.285 | 91H |
| T3R1½C1½ | 0.735 | 0.709 | 90 | 0.244 | 0.240 | 77 |
| T3R1½C3½ | 0.720 | 0.628 | 84 | 0.257 | 0.245 | 80H |
| T3R2½C2½ | 0.739 | 0.720 | 91 | 0.264 | 0.244 | 81H |
| T3R3C1 | 0.651 | 0.749 | 87 | 0.237 | 0.257 | 79 |
| T3R3C3 | 0.762 | 0.719 | 92H | 0.327 | 0.284 | 97H |
| T3R3½C1½ | 0.755 | 0.778 | 95H | 0.273 | 0.247 | 83H |
| T3R5C1 | 0.775 | 0.727 | 93H | 0.220 | 0.232 | 72 |
| T4R1C1 | 0.589 | 0.582 | 73 L | 0.213 | 0.189 | 64 L |
| T4R1C4 | 0.632 | 0.615 | 78 | 0.248 | 0.256 | 80H |
| T4R2C2 | 0.655 | 0.699 | 84 | 0.227 | 0.242 | 75 |
| T4R4C1 | 0.744 | 0.677 | 88 | 0.251 | 0.221 | 75 |
| T5R1C1 | 0.543 | 0.614 | 72 L | 0.194 | 0.204 | 63 L |
| T5R1C3 | 0.608 | 0.658 | 79 | 0.223 | 0.230 | 72 |
| T5R1½C1½ | 0.665 | 0.678 | 84 | 0.256 | 0.222 | 76 |
| T5R3C1 | 0.736 | 0.736 | 92H | 0.239 | 0.241 | 76 |
| T6R1½C1½ | 0.622 | 0.609 | 77 L | 0.211 | 0.213 | 68 L |
| T7R1C1 | 0.623 | 0.537 | 72 L | 0.227 | 0.208 | 69 L |
| Shive | ---------- | ---------- | 100H | ---------- | ---------- | 70 |
| Tottingham | ---------- | ---------- | 93H | ---------- | ---------- | 93H |

TABLE 8.—*Water-absorption data for wheat; also, amount of water absorbed for each gram of yield of tops and of roots (water requirement), relative to the highest average as 100; for series II, conducted from February 12 to March 7, 1916.*

| Culture No. | Water absorption. | | | Water requirement. | |
|---|---|---|---|---|---|
| | A, actual. | B, actual. | Average, relative. | Tops, average, relative. | Roots, average, relative. |
| | *cc.* | *cc.* | | | |
| T1R1C1 | 304 | 283 | *73L* | 81 | 94H |
| T1R1C4 | 408 | 382 | 98H | 81 | 97H |
| T1R1C7 | 417 | 375 | 99H | 100H (656) | 78L |
| T1R2C2 | 378 | 350 | 91L | 79L | 94H |
| T1R2C5 | 391 | 339 | 91L | 88 | 83L |
| T1R3C3 | 386 | 372 | 94 | 79L | 94H |
| T1R4C1 | 355 | 351 | 88L | 78L | 92 |
| T1R4C4 | 380 | 357 | 92 | 79L | 74L |
| T1R5C2 | 406 | 384 | 98H | 79L | 88 |
| T1R7C1 | 394 | 374 | 96 | 75L | 90 |
| T2R1C1 | 304 | 304 | 76L | 84 | 98 |
| T2R1C3½ | 380 | 352 | 91L | 86 | 100H (1768) |
| T2R1 | | | | | |
| T2R1C6 | 369 | 364 | 91L | 90H | 86L |
| T2R1⅔C1⅔ | 382 | 372 | 94 | 84 | 95H |
| T2R1⅔C4⅔ | 400 | 373 | 96 | 85 | 84L |
| T2R2⅔C2⅔ | 398 | 363 | 95 | 78L | 91 |
| T2R3⅓C1 | 363 | 326 | 86L | 79L | 91 |
| T2R3⅓C3½ | 399 | 388 | 98H | 79L | *71L* |
| T2R4⅔C1⅔ | 380 | 374 | 94 | *72L* | 92 |
| T2R6C1 | 390 | 362 | 94 | 74L | 91 |
| T3R1C1 | 363 | 342 | 88L | 87H | 98 |
| T3R1C3 | 369 | 363 | 91L | 91H | 98H |
| T3R1C5 | 414 | 389 | 100H (402) | 95H | 79L |
| T3R1⅔C1⅔ | 399 | 385 | 98H | 83 | 92 |
| T3R1⅔C3⅔ | 388 | 382 | 96 | 87H | 87L |
| T3R2⅓C2⅓ | 403 | 393 | 99H | 83 | 89 |
| T3R3C1 | 410 | 368 | 97H | 85 | 89 |
| T3R3C3 | 417 | 386 | 100H | 83 | 74L |
| T3R3⅔C1⅔ | 402 | 374 | 97H | 77L | 84L |
| T3R5C1 | 373 | 363 | 92 | 75L | 92 |
| T4R1C1 | 341 | 337 | 84L | 88H | 95H |
| T4R1C4 | 400 | 394 | 99H | 97H | 89 |
| T4R2C2 | 388 | 367 | 94 | 85 | 91 |
| T4R4C1 | 383 | 356 | 92 | 79L | 89 |
| T5R1C1 | 354 | 333 | 86L | 91H | 98H |
| T5R1C3 | 382 | 371 | 94 | 91H | 94H |
| T5R1⅔C1⅔ | 397 | 359 | 94 | 86 | 90 |
| T5R3C1 | 383 | 382 | 95 | 79L | 90 |
| T6R1⅓C1⅓ | 360 | 343 | 88L | 87H | 94H |
| T7R1C1 | 366 | 335 | 87L | 92H | 91 |
| Shive | | | 95 | 72L | 90 |
| Tottingham | | | 98H | 80 | 77L |

From the dry-weight data of both series I and series II it appears that for a given total concentration these plants were not very sensitive to small differences in the salt proportions. A relatively large number of salt combinations in both series I and series II gave approximately equal growth, with apparently identical conditions other than those in the nutrient solution. Thus in series I eleven other solutions gave at least nine-tenths as high dry yields of tops as did the best solution; and in series II twelve other solutions gave at least nine-tenths of the yield of tops obtained in the best solution. The individual differences between the different plants in a culture is probably the greatest factor in determining just which set of a number of very favorable sets of salt proportions will give the very highest yield.

The relation between the cation-ratio values and the yields of wheat tops for series I and II are shown in Table 9. It will be seen that for low yields of tops the Mg/Ca-ratio values cover practically the whole range of these values for the entire series. There is thus no relation between the value of the Mg/Ca-ratio and the low yield of tops. The same thing is also true of the values of the Mg/K- and Ca/K-ratios, since all tested values of these ratios give low yields in some cultures.

TABLE 9.—*Cation-ratio values for solutions of series I and II; for the entire series, and for solutions giving high and low and highest and lowest top yields.*

| | Mg/Ca. | | Mg/K. | | Ca/K. | |
|---|---|---|---|---|---|---|
| | Series I. | Series II. | Series I. | Series II. | Series I. | Series II. |
| Entire series: | | | | | | |
| Minima | 0.21 | 0.21 | 0.14 | 0.14 | 0.08 | 0.08 |
| Maxima | 13.43 | 13.43 | 4.68 | 4.68 | 2.68 | 2.68 |
| Range | 13.22 | 13.22 | 4.54 | 4.54 | 2.60 | 2.60 |
| Low yields: | | | | | | |
| Minima | 0.54 | 0.21 | 0.14 | 0.14 | 0.08 | 0.08 |
| Maxima | 13.43 | 13.43 | 4.68 | 4.68 | 2.27 | 2.68 |
| Range | 12.89 | 13.22 | 4.54 | 4.54 | 2.19 | 2.60 |
| High yields: | | | | | | |
| Minima | 0.53 | 0.53 | 0.14 | 0.14 | 0.08 | 0.08 |
| Maxima | 3.52 | 1.73 | 0.93 | 0.70 | 0.73 | 0.45 |
| Range | 2.99 | 1.20 | 0.79 | 0.66 | 0.65 | 0.37 |
| Highest yields | 1.72 | 1.72 | 0.40 | 0.29 | 0.23 | 0.17 |
| Lowest yields | 13.43 | 13.43 | 4.68 | 4.68 | 0.35 | 0.35 |
| Do | ---------- | 11.35 | ---------- | 2.61 | ---------- | 0.23 |

For high yields of tops, however, there does appear to be a certain relation between cation-ratio values and yield. High yields of tops were restricted to cultures having values of the Mg/Ca-ratio ranging from 0.53 to 3.52 for series I, and from 0.53 to 1.73 for series II, while the total range for each of these entire series was from 0.21 to 13.43. Thus high yields of tops were never obtained when the Mg/Ca-ratio value was above 3.52, no matter what the proportions of the other ions. High yields of tops were obtained when the Mg/K-ratio had the lowest value tested (0.14), and were restricted to relatively low values of this ratio. The highest value of the Mg/K-ratio that gave high yields was 0.93, while the highest value tested was 4.64. High yields of tops were also restricted to low values of the Ca/K-ratio, never being obtained when this was higher than 0.73, while the highest value for the entire series was 2.68. The very lowest value (0.08) of the Ca/K-ratio also produced high yields of tops. The data presented in this table may be summarized by stating that low yields were obtained with practically all ratio values tested; but that high yields were never obtained when the Mg/Ca-ratio was higher than 3.52, nor when the Mg/K-value was above 0.93, nor when the Ca/K-value was above 0.73.

Culture T1R1C1, which gave the lowest yields of tops in series I and II, had the following ratio values: Mg/Ca, 13.43; Mg/K, 4.68; Ca/K, 0.35. The other culture in series II giving a yield as low as T1R1C1 (namely culture T2R1C1) had the following values: Mg/Ca, 11.35; Mg/K, 2.61; and Ca/K, 0.23. The highest yields of tops were obtained, in series I, with culture T2R4C2 having the following ratio values: Mg/Ca, 1.72; Mg/K, 0.40; Ca/K, 0.23; and in series II, with culture T2R4$\frac{2}{3}$C1$\frac{2}{3}$ having the ratio values: Mg/Ca, 1.72; Mg/K, 0.29; Ca/K, 0.17. These two solutions are characterized by equal Mg/Ca-ratios; but the other two ratios are different for the two solutions.

The relations between cation-ratio values and root yields for series I and II are shown in Table 10. Considering the results of the two series together, it is apparent that there is little or no relation between low root yield and the value of any one of the three cation ratios. This agrees with what was found for top yields. However, as in the case of top yields, there was an apparent relation between high yields and cation-ratio values. Thus, high root yields were obtained only when the Mg/Ca-ratio had values from 0.21 to 5.48, while the total range for the series was from 0.21 to 13.43. In a similar way high root yields were restricted to low values of the Mg/K-ratio, from 0.14 to 0.80, and never occurred with ratio values between 0.80 and 4.68. On the other hand, there was no relation between high root yields and the Ca/K-ratio values, high yields being obtained with the whole range of these values tested.

The general conclusion which must be reached from these experiments is similar to that already stated by Gile,[51] by Tottingham, and by Shive. The effect of a certain ratio between any two ions in a certain total concentration appears to depend upon the relation of these ions to all the other ions in the nutrient solution; that is, upon the complex balance of ions in the nutrient solution. A certain optimum ratio may be found between two ions, as calcium and magnesium, for example, when a certain balance exists between all the other ions present. But if this balance is altered, the optimum ratio between calcium and magnesium, for example, would be altered.

TABLE 10.—*Cation-ratio values for solutions of series I and II; for the entire series, and for solutions giving high and low and highest and lowest root yields.*

| | Mg/Ca. | | Mg/K. | | Ca/K. | |
|---|---|---|---|---|---|---|
| | Series I. | Series II. | Series I. | Series. II. | Series I. | Series II. |
| **Entire series:** | | | | | | |
| Minima | 0.21 | 0.21 | 0.14 | 0.14 | 0.08 | 0.08 |
| Maxima | 13.43 | 13.43 | 4.68 | 4.68 | 2.68 | 2.68 |
| Range | 13.22 | 13.22 | 4.54 | 4.54 | 2.60 | 2.60 |
| **Low yields:** | | | | | | |
| Minima | 0.54 | 1.65 | 0.14 | 0.14 | 0.08 | 0.08 |
| Maxima | 13.43 | 13.43 | 4.68 | 4.68 | 2.27 | 0.85 |
| Range | 12.89 | 12.78 | 4.54 | 4.54 | 2.19 | 0.77 |
| **High yields:** | | | | | | |
| Minima | 0.31 | 0.21 | 0.14 | 0.19 | 0.08 | 0.17 |
| Maxima | 5.48 | 1.75 | 0.75 | 0.80 | 2.68 | 2.68 |
| Range | 5.17 | 1.54 | 0.61 | 0.61 | 2.60 | 2.51 |
| **Highest yields** | 0.53 | 0.45 | 0.19 | 0.20 | 0.35 | 0.45 |
| **Lowest yields** | 1.02 | 13.43 | 1.91 | 4.68 | 1.88 | 0.85 |

*Water absorption.*—Cultures T3R1C5 and T3R3C3 absorbed the greatest quantities of water in this series; the latter culture also absorbed the most in series I. This series agrees with series I in the culture showing lowest water absorption (T1R1C1). In a general way, also, there is an agreement between the two series in the direct relationship shown between dry yields of tops and roots, on the one hand, and water absorption on the other.

*Water requirement.*—The results of this series disagreed with those of the preceding one in the exact proportions giving high-

[51] Gile, P. L., Lime-magnesia ratio as influenced by concentration, Bull. Porto Rico Agric. Exp. Sta. 12 (1912).

est and lowest top and highest and lowest root water requirements, though there was general agreement between the high and low and medium areas for the two series. The general features are the same as those for the preceding series and will not be discussed in detail here.

## SERIES III

### METHODS OF SERIES III

Series III extended over thirty-two days, from December 4, 1916, to January 5, 1917. The maximum temperature for this period was 28° C. (December 8, 13, 14, 21), and the minimum was 12° C. (December 15, 17, 30). The average daily maximum for the period was 25° C., and the average daily minimum was 16° C. The mean daily water loss from the atmometer was 15.7 cubic centimeters, and the total loss for the period was 501 cubic centimeters.

All of the culture solutions employed in this series had the same total concentration (1.60 atmospheres) as was used in series I and II. But much higher partial concentrations of potassium chloride were included in this series, since the results obtained from the preceding series showed no very pronounced effects that might be attributed to potassium chloride. Four sets of culture solutions were used, in which potassium chloride contributed 0.2, 0.7, 0.8, and 0.9, respectively, of the total osmotic concentration. In each of these sets ten combinations of the other three salts were tested. The method of varying the other three salts may be most easily understood by referring to the diagrams of fig. 7. Each of the four triangles (T2, T7, T8, T9) represents one of these four sets. The cultures of the first set (T2) have 0.2, those of the second (T7) have 0.7, those of the third (T8) have 0.8, and those of the fourth (T9) have 0.9 of their total osmotic concentration due to potassium chloride.

In each of the sets the residual osmotic concentration is distributed among the other three salts in the way shown by the distribution of the dots on the diagrams. Thus in triangle 2 the distribution was 0.8 of the total concentration; in triangle 7, 0.3; in triangle 8, 0.2; and in triangle 9, 0.1. Each of the cultures indicated on the triangular diagrams of fig. 7 represents various proportions of monopotassium phosphate, calcium nitrate, and magnesium sulphate, the amount of potassium chloride being indicated by the number of the triangle. Thus the cultures in each set may be regarded as comprising a series of three-salt solutions similar to the series employed by Shive. The diagram (T0) of fig. 7 represents Shive's series, consisting of

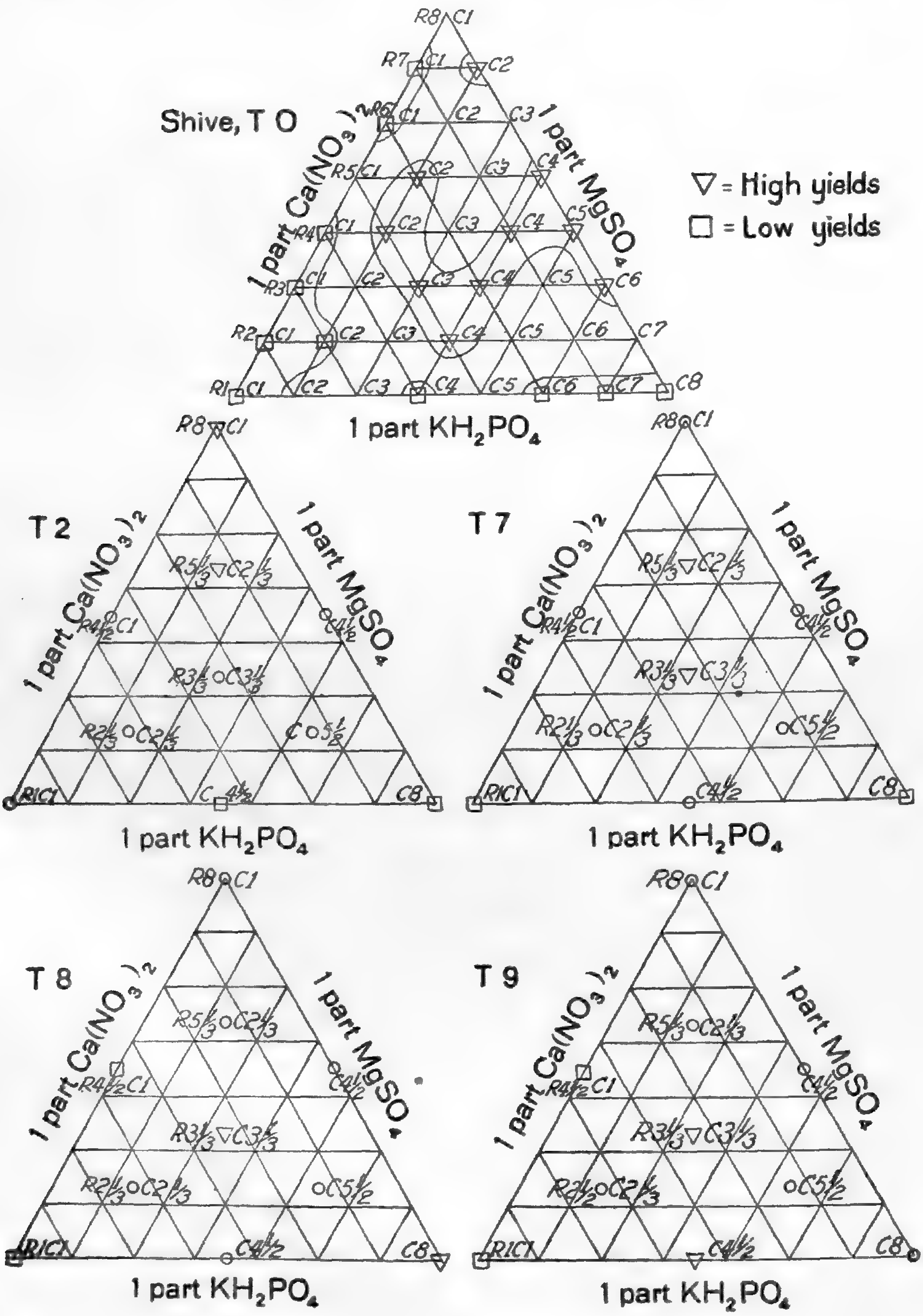


FIG. 7. Diagram for series III, showing culture numbers and osmotic proportions of the four salts.

thirty-six solutions having various proportions of monopotassium phosphate, calcium nitrate, and magnesium sulphate, all of which have the same total concentration (1.75 atmospheres). None of these solutions contains any potassium chloride at all. The set of cultures represented by triangle 2 may be considered as derived from Shive's series by first decreasing the total concentration of the latter to 1.28 atmospheres and then adding to each solution enough potassium chloride to give a total concentration of 1.60 atmospheres. Similarly, the sets represented by triangles 7, 8, and 9 may be derived from the Shive set by decreasing the total concentration to 0.48 atmosphere, 0.32 atmosphere, and 0.16 atmosphere, respectively, and then adding potassium chloride equivalent to 1.12 atmospheres, 1.28 atmospheres, and 1.44 atmospheres, respectively. It is thus seen that series III was planned to study the various physiological values (as indicated by the plants) of the different salt proportions in the Shive series, in the presence of four different partial concentrations of potassium chloride, the total concentration of the four-salt mixture being always the same (1.60 atmospheres).

The actual salt proportions tested in this series were not exactly the same as those employed by Shive, but the total range of salt proportions was the same. Instead of the thirty-six solutions tested by Shive, ten selected solutions were here employed. Only three of these ten correspond to sets of proportions actually used by Shive (those represented by the three apices of the diagram). The others fall on the diagram at different points from those actually tested by Shive, but they may be designated in the same general manner as was followed by Shive, by employing fractional numerals somewhat as in the case of series II. Culture T2R4½C1, for example, considered as a three-salt solution having an osmotic value of 1.28 atmospheres has 0.4½ due to monopotassium phosphate, 0.1 due to calcium nitrate, and 0.4½ due to magnesium sulphate, and the amount of potassium chloride present is shown by the number of the triangle (0.2 of 1.60=0.32 atmosphere). Besides the forty solutions belonging to this series, solution T2R4C2 (giving the highest top yield in series I) was also employed, for the sake of comparison.

Table 11 gives the chemical composition of each of the forty solutions in series III, in terms of the partial volume-molecular concentrations of the four salts; the values of the three cation ratios are also included in this table. The method used in calculating these partial concentrations was similiar to that employed heretofore.

TABLE 11.—*Partial concentrations of each of the salts in the solutions employed in series III; also, the values of the three cation ratios; total osmotic value of each solution, 1.60 atmospheres.*

| Culture No. | Volume-molecular partial concentration. | | | | Cation-ratio value. | | |
|---|---|---|---|---|---|---|---|
| | KCl. | $KH_2PO_4$. | $Ca(NO_3)_2$ | $MgSO_4$. | Mg/Ca. | Mg/K. | Ca/K. |
| | *M.* | *M.* | *M.* | *M.* | | | |
| T2R1C1 | 0.0067 | 0.0028 | 0.0020 | 0.0280 | 14.00 | 2.95 | 0.21 |
| T2R1C4½ | 0.0067 | 0.0028 | 0.0090 | .0158 | 1.76 | 1.66 | 0.95 |
| T2R1C 8 | 0.0067 | 0.0028 | 0.0161 | 0.0035 | 0.22 | 0.37 | 1.69 |
| T2R2⅔C2⅔ | 0.0067 | 0.0065 | 0.0047 | 0.0187 | 3.98 | 1.42 | 0.36 |
| T2R2⅔C5⅓ | 0.0067 | 0.0065 | 0.0107 | 0.0082 | 0.77 | 0.62 | 0.81 |
| T2R3⅓C3⅓ | 0.0067 | 0.0093 | 0.0067 | 0.0117 | 1.75 | 0.73 | 0.42 |
| T2R4½C1 | 0.0067 | 0.0125 | 0.0020 | 0.0158 | 7.90 | 0.82 | 0.10 |
| T2R4½C4½ | 0.0067 | 0.0125 | 0.0090 | 0.0035 | 0.39 | 0.18 | 0.47 |
| T2R5⅓C2⅔ | 0.0067 | 0.0148 | 0.0047 | 0.0082 | 1.75 | 0.38 | 0.22 |
| T2R8C1 | 0.0067 | 0.0222 | 0.0020 | 0.0035 | 1.75 | 0.12 | 0.07 |
| T7R1C1 | 0.0240 | 0.00103 | 0.00072 | 0.00983 | 13.65 | 0.39 | 0.03 |
| T7R1C4½ | 0.0240 | 0.00103 | 0.00323 | 0.00553 | 1.71 | 0.22 | 0.13 |
| T7R1C8 | 0.0240 | 0.00103 | 0.00575 | 0.00123 | 0.21 | 0.05 | 0.23 |
| T7R2⅔C2⅔ | 0.0240 | 0.00240 | 0.00168 | 0.00655 | 3.90 | 0.25 | 0.06 |
| T7R2⅔C5⅓ | 0.0240 | 0.00240 | 0.00383 | 0.00287 | 0.75 | 0.11 | 0.15 |
| T7R3⅓C3⅓ | 0.0240 | 0.00343 | 0.00240 | 0.00410 | 1.71 | 0.15 | 0.09 |
| T7R4½C1 | 0.0240 | 0.00464 | 0.00072 | 0.00553 | 7.68 | 0.19 | 0.03 |
| T7R4½C4½ | 0.0240 | 0.00464 | 0.00323 | 0.00123 | 0.38 | 0.04 | 0.11 |
| T7R5⅓C2⅔ | 0.0240 | 0.00549 | 0.00168 | 0.00287 | 1.71 | 0.10 | 0.06 |
| T7R8C1 | 0.0240 | 0.00824 | 0.00072 | 0.00123 | 1.71 | 0.04 | 0.02 |
| T8R1C1 | 0.0275 | 0.00068 | 0.00047 | 0.00639 | 13.60 | 0.23 | 0.02 |
| T8R1C4½ | 0.0275 | 0.00068 | 0.00213 | 0.00359 | 1.69 | 0.13 | 0.08 |
| T8R1C8 | 0.0275 | 0.00068 | 0.00378 | 0.00080 | 0.21 | 0.03 | 0.13 |
| T8R2⅔C2⅔ | 0.0275 | 0.00159 | 0.00110 | 0.00426 | 3.87 | 0.15 | 0.04 |
| T8R2⅔C5⅓ | 0.0275 | 0.00159 | 0.00252 | 0.00186 | 0.74 | 0.06 | 0.09 |
| T8R3⅓C3⅓ | 0.0275 | 0.00227 | 0.00157 | 0.00266 | 1.69 | 0.09 | 0.05 |
| T8R4½C1 | 0.0275 | 0.00307 | 0.00047 | 0.00359 | 7.64 | 0.12 | 0.02 |
| T8R4½C4½ | 0.0275 | 0.00307 | 0.00213 | 0.00080 | 0.38 | 0.03 | 0.07 |
| T8R5⅓C2⅔ | 0.0275 | 0.00364 | 0.00110 | 0.00186 | 1.69 | 0.06 | 0.04 |
| T8R8C1 | 0.0275 | 0.00546 | 0.00047 | 0.00080 | 1.70 | 0.02 | 0.01 |
| T9R1C1 | 0.0310 | 0.00034 | 0.00023 | 0.00305 | 13.26 | 0.10 | 0.01 |
| T9R1C4½ | 0.0310 | 0.00034 | 0.00104 | 0.00172 | 1.65 | 0.05 | 0.03 |
| T9R1C8 | 0.0310 | 0.00034 | 0.00185 | 0.00038 | 0.21 | 0.01 | 0.06 |
| T9R2⅔C2⅔ | 0.0310 | 0.00078 | 0.00054 | 0.00203 | 3.76 | 0.06 | 0.02 |
| T9R2⅔C5⅓ | 0.0310 | 0.00078 | 0.00123 | 0.00089 | 0.72 | 0.03 | 0.04 |
| T9R3⅓C3⅓ | 0.0310 | 0.00112 | 0.00077 | 0.00127 | 1.65 | 0.04 | 0.02 |
| T9R4½C1 | 0.0310 | 0.00151 | 0.00023 | 0.00172 | 7.48 | 0.05 | 0.01 |
| T9R4½C4½ | 0.0310 | 0.00151 | 0.00104 | 0.00038 | 0.37 | 0.01 | 0.03 |
| T9R5⅓C1⅓ | 0.0310 | 0.00179 | 0.00054 | 0.00089 | 1.65 | 0.03 | 0.02 |
| T9R8C1 | 0.0310 | 0.00269 | 0.00023 | 0.00038 | 1.65 | 0.01 | 0.01 |

RESULTS OF SERIES III

*Appearance of the plants.*—The same kinds of top and root modifications described for series I and II were observed in the present series, with the exception of the longitudinal striping of the leaves and the phenomenon similar to "stooling," which did not appear. Retardation of lateral roots was most pronounced in culture T2R1C1, but it was also severe in cultures T7R1C1, T8R1C1, and T9R1C1. Here also the color of the tops was seen to decrease in intensity in passing from left to right in the triangles; and all of the plants in the cultures of triangle 2 were greener than the plants in the corresponding cultures of triangles 7, 8, and 9. The forms of leaf injury apparently related to high partial concentrations of magnesium sulphate were observed in this series, and their distribution is shown upon the diagrams of fig. 8. In these diagrams the total number of leaves of the twelve plants grown in the duplicate cultures are indicated by the numerals placed near the points showing the location of culture solutions. Cultures marked by triangles showed severe injury; those marked by squares showed slight injury.

*Dry weights.*—The actual dry weights, in grams, of tops and of roots, are given in Table 12. The dry weights of the plants of each of the two duplicate cultures and the average weights are shown. High yields are indicated in the table by the letter H; and low, by the letter L; the two highest yields in each triangle are considered high and the two lowest are considered low, for tops and for roots. The actual yields obtained at the same time with the T2R4C2 cultures are given at the bottom of the table. The data given in this table are shown diagrammatically in fig. 7 (tops) and fig. 9 (roots). The method of plotting is somewhat different from that previously employed; in this case high values are indicated by small triangles and low values by small squares, no attempt being made to indicate areas of high and low values.

*Water absorption.*—The data on water absorption for the cultures in this series are shown in Table 13, where the arrangement is similar to that in the preceding table.

*Water requirement.*—The average amounts of water absorbed per unit of dry weight of tops and of roots are presented in the last two columns in Table 13.

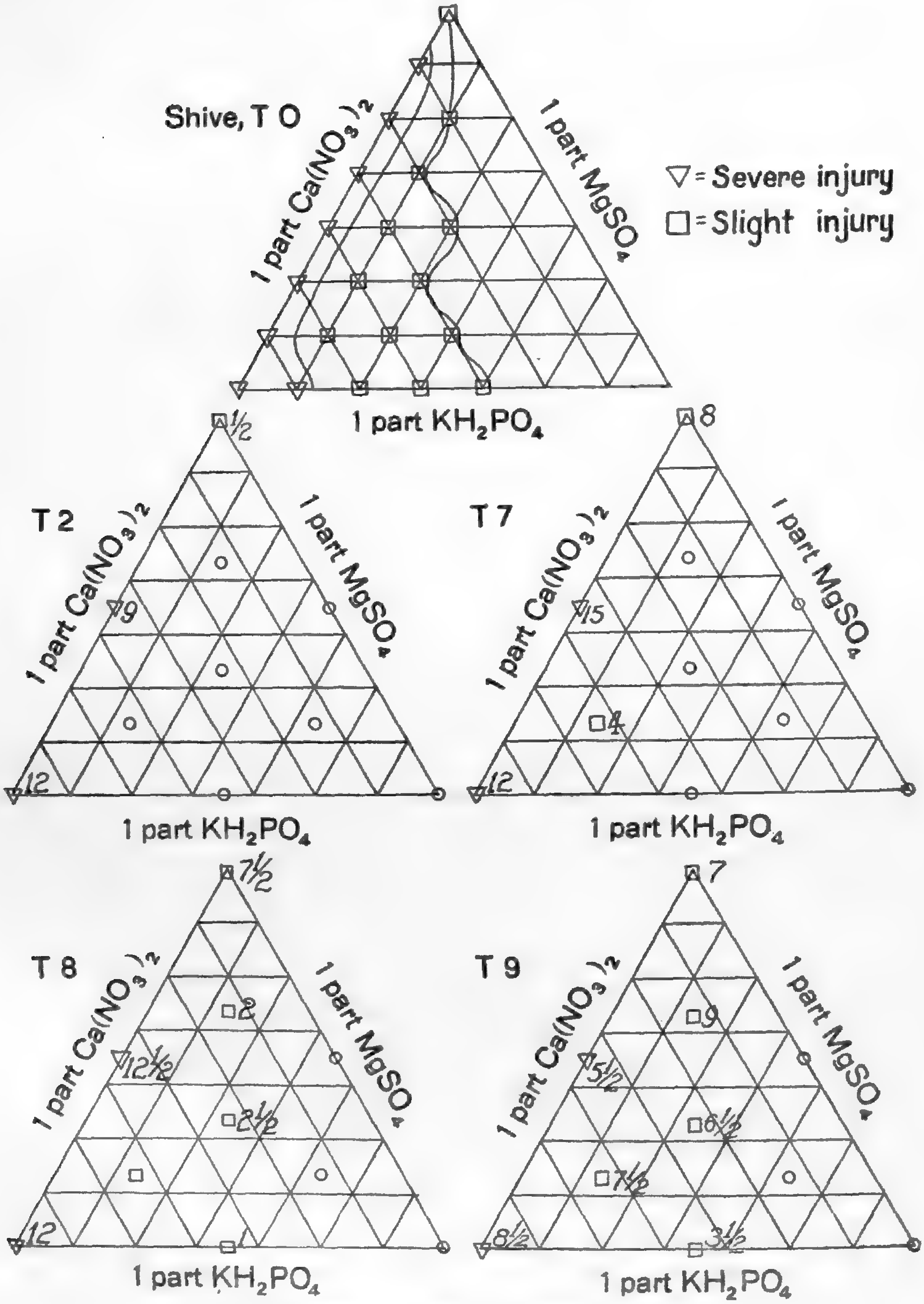


FIG. 8. Diagram for series III, showing leaf injury.

## DISCUSSION OF SERIES III

*Appearance of plants.*—From the data shown in fig. 8, it appears that the area of magnesium injury on the triangular diagram employed for this series is very small when the amount of potassium chloride present is low and becomes larger as the

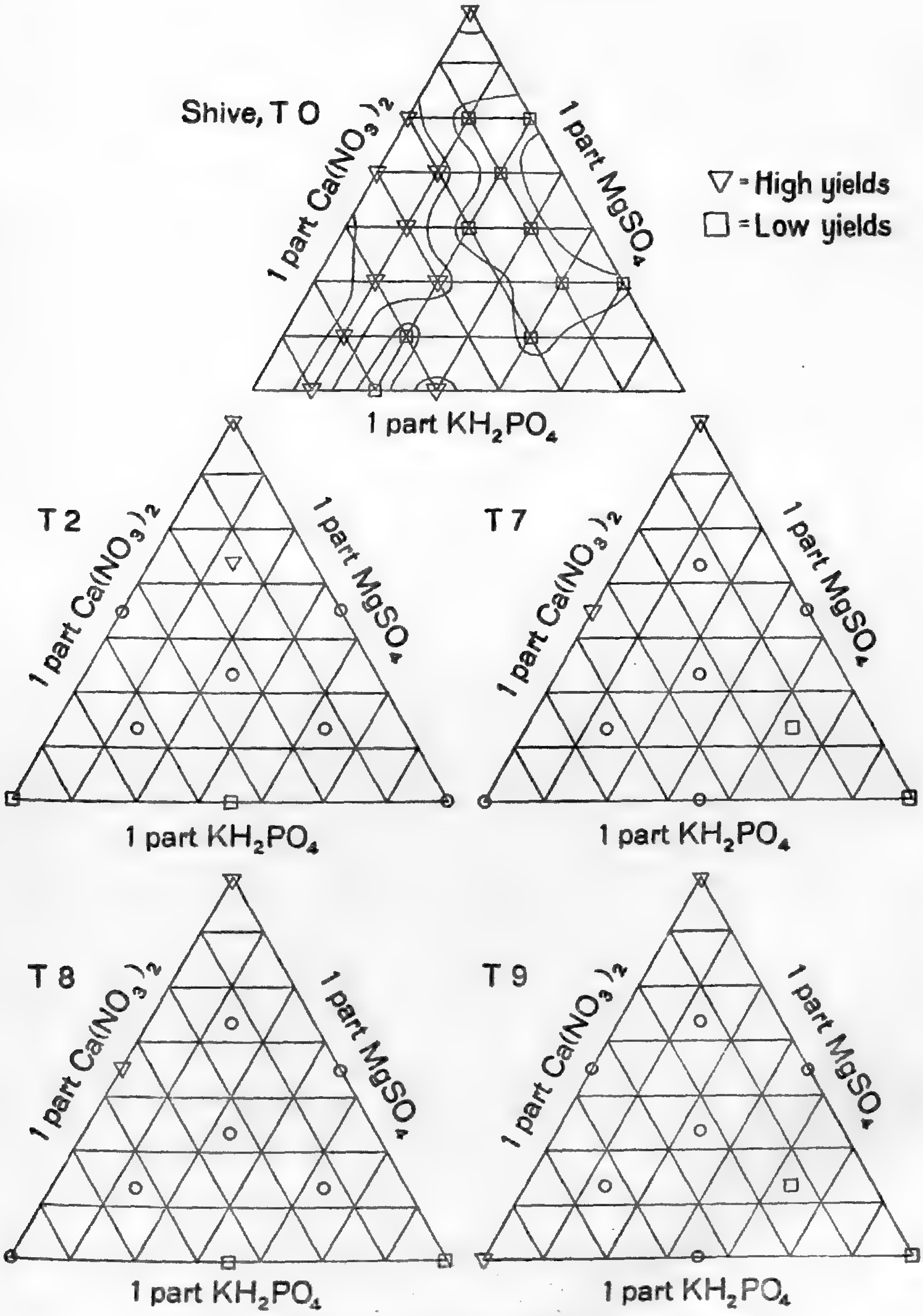


FIG. 9. Diagram for series III, showing dry yields of roots.

amount of this salt is increased. Thus in triangle 2, where only 0.2 of the total concentration is due to potassium chloride, this area of injury is confined to the left margin; it extends somewhat more to the right in triangle 7; and occupies the left half of the diagram in triangles 8 and 9. In the last two cases potassium chloride was present in very large amounts (0.8 and 0.9 of the total osmotic value, respectively). It is remarkable that the set of cultures represented by triangle 2 is most nearly like the Shive set (which contained no potassium chloride), but that

TABLE 12.—*Dry weights of tops and roots of wheat; for series III, conducted from December 4, 1916, to January 5, 1917.*

| Culture No. | Tops (6 plants). | | | Roots (6 plants). | | |
|---|---|---|---|---|---|---|
| | A. | B. | Average. | A. | B. | Average. |
| | *g.* | *g.* | *g.* | *g.* | *g.* | *g.* |
| T2R1C1 | 0.719 | 0.711 | 0.715 | 0.210 | 0.205 | 0.208L |
| T2R1C4½ | 0.692 | 0.685 | 0.689L | 0.197 | 0.193 | 0.195L |
| T2R1C8 | 0.704 | 0.642 | 0.673L | 0.242 | 0.209 | 0.226 |
| T2R2⅓C2⅓ | 0.851 | 0.825 | 0.838 | 0.225 | 0.221 | 0.223 |
| T2R2⅓C5⅓ | 0.795 | 0.773 | 0.784 | 0.237 | 0.217 | 0.227 |
| T2R3⅓C3⅓ | 0.870 | 0.842 | 0.856 | 0.240 | 0.221 | 0.231 |
| T2R4½C1 | 0.847 | 0.878 | 0.863 | 0.233 | 0.223 | 0.228 |
| T2R4½C4½ | 0.820 | 0.857 | 0.839 | 0.308 | 0.278 | 0.293H |
| T2R5⅓C2⅓ | 0.955 | 0.938 | 0.947H | 0.262 | 0.240 | 0.251H |
| T2R8C1 | 0.939 | 0.872 | 0.906H | 0.256 | 0.234 | 0.245 |
| T7R1C1 | 0.466 | 0.473 | 0.470L | 0.221 | 0.215 | 0.218 |
| T7R1C4½ | 0.617 | 0.532 | 0.575 | 0.215 | 0.194 | 0.205 |
| T7R1C8 | 0.491 | 0.592 | 0.542L | 0.205 | 0.177 | 0.191L |
| T7R2⅓C2⅓ | 0.585 | 0.614 | 0.600 | 0.215 | 0.195 | 0.205 |
| T7R2⅓C5⅓ | 0.585 | 0.579 | 0.582 | 0.201 | 0.186 | 0.194L |
| T7R3⅓C3⅓ | 0.616 | 0.658 | 0.637H | 0.230 | 0.219 | 0.225 |
| T7R4½C1 | 0.555 | 0.531 | 0.543 | 0.256 | 0.216 | 0.236H |
| T7R4½C4½ | 0.625 | 0.607 | 0.616 | 0.212 | 0.202 | 0.207 |
| T7R5⅓C2⅓ | 0.656 | 0.607 | 0.632H | 0.232 | 0.201 | 0.217 |
| T7R8C1 | 0.563 | 0.568 | 0.566 | 0.248 | 0.244 | 0.246H |
| T8R1C1 | 0.448 | 0.435 | 0.442L | 0.234 | 0.216 | 0.225 |
| T8R1C4½ | 0.470 | 0.553 | 0.512 | 0.203 | 0.178 | 0.191L |
| T8R1C8 | 0.599 | 0.574 | 0.587H | 0.196 | 0.186 | 0.191L |
| T8R2⅓C2⅓ | 0.474 | 0.537 | 0.506 | 0.217 | 0.208 | 0.213 |
| T8R2⅓C5⅓ | 0.504 | 0.598 | 0.551 | 0.209 | 0.197 | 0.203 |
| T8R3⅓C3⅓ | 0.620 | 0.548 | 0.584H | 0.247 | 0.212 | 0.230 |
| T8R4½C1 | 0.433 | 0.512 | 0.473L | 0.294 | 0.229 | 0.262H |
| T8R4½C4½ | 0.510 | 0.531 | 0.521 | 0.207 | 0.199 | 0.203 |
| T8R5⅓C2⅓ | 0.594 | 0.537 | 0.566 | 0.235 | 0.226 | 0.231 |
| T8R8C1 | 0.492 | 0.467 | 0.480 | 0.263 | 0.263 | 0.263H |
| T9R1C1 | 0.467 | 0.410 | 0.439L | 0.332 | 0.316 | 0.324H |
| T9R1C4½ | 0.541 | 0.593 | 0.567H | 0.240 | 0.203 | 0.222 |
| T9R1C8 | 0.526 | 0.522 | 0.524 | 0.215 | 0.194 | 0.205L |
| T9R2⅓C2⅓ | 0.512 | 0.502 | 0.507 | 0.288 | 0.255 | 0.272 |
| T9R2⅓C5⅓ | 0.564 | 0.496 | 0.530H | 0.223 | 0.211 | 0.217L |
| T9R3⅓C3⅓ | 0.488 | 0.572 | 0.530H | 0.249 | 0.221 | 0.235 |
| T9R4½C1 | 0.420 | 0.417 | 0.419L | 0.301 | 0.291 | 0.296 |
| T9R4½C4½ | 0.480 | 0.565 | 0.523 | 0.229 | 0.214 | 0.222 |
| T9R5⅓C2⅓ | 0.512 | 0.478 | 0.495 | 0.280 | 0.254 | 0.267 |
| T9R8C1 | 0.440 | 0.458 | 0.449 | 0.316 | 0.303 | 0.310H |
| T2R4C2 | 0.937 | 0.937 | 0.937 | 0.252 | 0.241 | 0.247 |

**Table 13.**—*Water-absorption data for wheat; also, average amount of water absorbed for each gram of yield of tops and of roots (water requirement); for series III, conducted from December 4, 1916, to January 5, 1917.*

| Culture No. | Water-absorption. | | | Average water requirement. | |
|---|---|---|---|---|---|
| | A. | B. | Average. | Tops. | Roots. |
| | *cc.* | *cc.* | *cc.* | *cc. per g.* | *cc. per g.* |
| T2R1C1 | 383 | 363 | 373 | 522 | 1,793 |
| T2R1C4½ | 409 | 404 | 407 | 591 | 2,087 |
| T2R1C8 | 401 | 389 | 395 | 587 | 1,748 |
| T2R2⅓C2⅓ | 436 | 436 | 436 | 520 | 1,955 |
| T2R2⅓C5⅓ | 419 | 409 | 414 | 528 | 1,824 |
| T2R3⅓C3⅓ | 444 | 399 | 422 | 493 | 1,827 |
| T2R4½C1 | 425 | 411 | 418 | 484 | 1,833 |
| T2R4½C4½ | 432 | 418 | 425 | 507 | 1,451 |
| T2R5⅓C2⅓ | 442 | 432 | 437 | 461 | 1,741 |
| T2R8C1 | 456 | 435 | 446 | 492 | 1,820 |
| T7R1C1 | 338 | 324 | 331 | 704 | 1,518 |
| T7R1C4½ | 401 | 376 | 389 | 677 | 1,898 |
| T7R1C8 | 399 | 360 | 380 | 701 | 1,990 |
| T7R2⅓C2⅓ | 395 | 357 | 376 | 627 | 1,834 |
| T7R2⅓C5⅓ | 385 | 369 | 377 | 648 | 1,943 |
| T7R3⅓C3⅓ | 423 | 396 | 410 | 644 | 1,822 |
| T7R4½C1 | 334 | 327 | 331 | 610 | 1,403 |
| T7R4½C4½ | 390 | 381 | 386 | 627 | 1,865 |
| T7R5⅓C2⅓ | 387 | 378 | 383 | 606 | 1,765 |
| T7R8C1 | 375 | 344 | 360 | 636 | 1,463 |
| T8R1C1 | 333 | 317 | 325 | 735 | 1,444 |
| T8R1C4½ | 402 | 339 | 371 | 725 | 1,942 |
| T8R1C8 | 387 | 370 | 379 | 646 | 1,984 |
| T8R2⅓C3⅓ | 369 | 362 | 366 | 723 | 1,718 |
| T8R2⅓C5⅓ | 386 | 379 | 383 | 695 | 1,887 |
| T8R3⅓C3⅓ | 395 | 386 | 391 | 670 | 1,700 |
| T8R4½C1 | 364 | 322 | 343 | 725 | 1,309 |
| T8R4½C4½ | 387 | 354 | 371 | 712 | 1,828 |
| T8R5⅓C2⅓ | 399 | 387 | 393 | 694 | 1,701 |
| T8R8C1 | 351 | 345 | 348 | 725 | 1,323 |
| T9R1C1 | 315 | 314 | 315 | 718 | 972 |
| T9R1C4½ | 411 | 365 | 388 | 684 | 1,748 |
| T9R1C8 | 389 | 364 | 377 | 719 | 1,839 |
| T9R2⅓C2⅓ | 362 | 345 | 354 | 698 | 1,301 |
| T9R2⅓C5⅓ | 384 | 365 | 375 | 708 | 1,728 |
| T9R3⅓C3⅓ | 383 | 348 | 366 | 691 | 1,557 |
| T9R4½C1 | 319 | 303 | 311 | 742 | 1,051 |
| T9R4½C4½ | 386 | 340 | 363 | 694 | 1,635 |
| T9R5⅓C2⅓ | 360 | 337 | 349 | 705 | 1,307 |
| T9R8C1 | 320 | 319 | 320 | 713 | 1,032 |
| T2R4C2 | 441 | 435 | 438 | 467 | 1,773 |

triangles 8 and 9 are the ones that approach most nearly to Shive's diagram of magnesium injury. Whether the Shive series containing the three other salts without any potassium chloride might have shown the distribution of this injury recorded by Shive, if it had been carried out simultaneously with these four sets, is of course uncertain.

The more-intense green color that characterized the cultures with a large supply of magnesium sulphate in series I and II was also noted in this series; the region of deepest green occurred at the left margin in the triangle in all four cases. Furthermore, the color intensity of these greenest plants decreased from set to set as the potassium chloride content of the solution increased. As has been mentioned, the high potassium chloride content of these sets was accompanied by lower absolute amounts of the three other salts, so that the last observation may well be related to the small absolute amount of magnesium sulphate present in these solutions. Dwarfing of the root system also occurred in this series with high relative amounts of magnesium sulphate, as has been noted for series I and II, and this dwarfing was much more pronounced with high absolute values of this salt than with lower ones. As has been mentioned, striping of the leaves and "stooling" were not observed in series III.

*Dry weights.*—Reference to the diagrams of fig. 7 shows that as the partial concentration of potassium chloride is increased, the partial concentration of the other three salts together being correspondingly decreased, the area of high top values migrates downward and to the right; that is, toward lower relative proportions of monopotassium phosphate and higher ones of calcium nitrate. That this migration of the area of high tops is not due merely to decreased partial concentration of monopotassium phosphate, calcium nitrate, and magnesium sulphate is suggested by the fact that a similar decrease in the total concentration of Shive's solution (see Shive's paper, figs. 2 and 3) produced a markedly different change in the configuration of the triangle. The migration of the area in question was from the central to the right central portion; that is, toward higher proportions of calcium nitrate, but not toward lower proportions of monopotassium phosphate. But other evidence from the absolute values presented in Table 12 appears to indicate that the main effect here produced by increasing the partial concentration of potassium chloride is primarily related to the concomitant decrease in the partial concentration of the three salts used by Shive.

A set of cultures, which may be designated as series III A, was conducted in order to determine whether the low top yields obtained with high proportions of potassium chloride were due to the reduction in concentration of the essential salts or to the high concentration of potassium chloride itself. This series was carried out from January 23 to February 24, 1917. The dry-weight data for this series are shown in Table 14. Four solutions were used in this set. The first of these was the T7R1C1 solution, which was used in series I and II, and which, it will be remembered, has 0.7 of its osmotic concentration due to potassium chloride and 0.1 due to each of the other salts, monopotassium phosphate, calcium nitrate, and magnesium sulphate. This solution contains a very high proportion of potassium chloride. In both series I and series II it produced very low top yields. In the case of the second solution designated [T0R3$\frac{1}{3}$C3$\frac{1}{3}$ (0.48 atmosphere)], the composition was the same as that of the T7R1C1 solution, except that the potassium chloride was omitted. The dry yield of tops produced by this solution was 0.764 gram, while the yield from the T7R1C1 culture was 0.700 gram. It is thus clear that the omission of the potassium chloride did not markedly increase the yield of tops. The next solution [T0R3$\frac{1}{3}$ C3$\frac{1}{3}$ (1.60 atmospheres)] was derived from the T7R1C1 solution by the omission of potassium chloride and the addition of sufficient amounts of the other salts to give a total concentration of 1.60 atmospheres. It will be seen that this solution is similar to the second solution, but that the total concentration is here increased from 0.48 atmosphere to 1.60 atmospheres. The yield from this culture was 1.221 grams. Thus a very marked increase in yield is brought about by increasing the essential salts from the concentration in which they occur in the T7R1C1 solution (0.48 atmosphere) to a total of 1.60 atmospheres. The fourth solution of this set (T10R0C0) was a single-salt solution containing potassium chloride in sufficient amount to give an osmotic concentration of 1.60 atmospheres. The yield from this culture is very low, being only 0.265 gram. From this set of cultures it may be concluded that the very low yields obtained in series I, II, and III with very high proportions of potassium chloride were due principally to the reductions in the amounts of the essential salts and not to any specific effect of the potassium chloride.

TABLE 14.—*Dry weights of wheat tops and roots; for series III A, conducted from January 23 to February 24, 1917.*

| Culture No. | Nature of solution. | Dry weights (6 plants). Tops. | Dry weights (6 plants). Roots. |
|---|---|---|---|
| | | *g.* | *g.* |
| T7R1C1 (1.60 atmospheres) | 0.7 of osmotic concentration due to KCl, 0.1 to each of the other salts. | 0.712 | 0.269 |
| | | 0.687 | 0.255 |
| | | 0.700 | 0.262 |
| T0R3⅓C3⅓ (0.48 atmosphere) | The T7R1C1 solution with KCl omitted. Equal osmotic concentration of the essential salts. | 0.753 | 0.257 |
| | | 0.690 | 0.244 |
| | | 0.801 | 0.258 |
| | | 0.810 | 0.267 |
| | | 0.764 | 0.257 |
| T0R3⅓C3⅓ (1.60 atmospheres) | The T7R1C1 solution with KCl omitted and with concentration of other salts to give a total of 1.60 atmospheres. | 1.220 | 0.379 |
| | | 1.222 | 0.410 |
| | | 1.221 | 0.395 |
| T10R0C0 (1.60 atmospheres) | Single-salt solution with 1.60 atmospheres osmotic concentration due to KCl. | 0.258 | 0.100 |
| | | 0.272 | 0.105 |
| | | 0.265 | 0.103 |

Returning to series III, it will be seen that with all of the ten sets of proportions of the salts other than potassium chloride the greatest dry weight of tops was produced in the solution having the least amount of potassium chloride; that is, for each set of proportions the cultures of triangle 2 gave higher yields than did the corresponding cultures of triangles 7, 8, and 9. The weight of tops varied inversely with the proportion of chloride for the following combinations: R1C1, R2⅓C5⅓, R3⅓C3⅓, R4½C1, R5⅓C2⅓, R8C1. These data indicate that (with a given set of proportions of the essential salts) increased proportions of potassium chloride give decreased top production; though, as has been emphasized, this decrease is probably due merely to the accompanying decrease in the amounts of the essential elements.

The highest dry yield of roots was obtained with the greatest partial concentration (that is, in triangle 9) of potassium chloride with the following combinations of the essential salts: R1C1, R1C4½, R2⅓C2⅓, R3⅓C3⅓, R4½C1, R5⅓C2⅓, R8C1. Considering all four triangles, the weight of roots varied directly with the proportion of chloride for the following cultures: R1C1, R4½C1, and R8C1. The combinations which did not give greatest dry weight of roots with the greatest amount of chloride were R1C8, R2⅓C5⅓, R4½C4½. These solutions were characterized by the largest amounts of calcium nitrate and the smallest amounts of magnesium sulphate; that is, by low Mg/Ca values. These results indicate, therefore, that an increased proportion of potassium chloride gives increased root production, except in solutions having very low Mg/Ca values.

## SERIES IV

### METHODS OF SERIES IV

Series IV lasted thirty-two days, from January 23 to February 24, 1917, the period being of the same length as for series III. The maximum temperature during this period was 29° C. (February 4, 17, 21) and the minimum was 7° C. (February 11). The average daily maximum for the period was 25° C. and the average daily minimum was 13° C. The mean daily evaporation rate from the atmometers was 15.3 cubic centimeters, and the total loss was 491 cubic centimeters.

In this series it was planned to study the effect upon the plants of different total concentrations for the same set of salt proportions. Only three of the eighty-four sets were tested in this way, and with them was tested a three-salt solution, without potassium chloride, having the salt proportions nearly the same as those in Shive's best solution for wheat. For each one of these four sets of salt proportions eight different total concentrations were employed. The three sets of four-salt proportions used were as follows: (1) T7R1C1, which contained the maximum amount of potassium chloride occurring in any of the eighty-four solutions; (2) T1R1C1, which contained the maximum amount of magnesium sulphate present in any of the eighty-four solutions and which also had the poorest physiological balance for dry top yield in these plants; (3) T2R4C2, which had the best physiological balance for dry top yield. The three-salt solution in this series was one that is to be designated as R5C2½ on the Shive diagram.

For each one of these four sets of salt proportions the eight total concentrations tested, expressed in terms of their osmotic values, were as follows: 0.50, 1.00, 1.60, 2.50, 3.50, 4.50, 5.50 and 7.00 atmospheres. It will be noticed that the third one of these concentrations (1.60 atmospheres) is the one employed in all of the preceding series.

The calculations were based upon the data given for series I, and the various concentrations were obtained by first preparing a solution having an assumed osmotic value of 7.00 atmospheres and then diluting this to give the concentrations required. The assumption is here made that the ionization constants for the salts are the same for the lower and higher concentrations as they are for the solution having an osmotic value of 1.60 atmospheres. This method, therefore, is not strictly accurate. The error thus introduced is practically negligible for the solutions having values below 1.60 atmospheres. For the higher concentrations, freezing-point determinations indicated that this error gradually increased with the total concentration until it amounted to about 8 per cent. Thus solution T1R1C1, planned to have an osmotic value of 7.00 atmospheres at 25° C., proved by the freezing-point method to have an actual value corresponding to 6.50 atmospheres at 25° C. Since the purpose of this series was to study only the general relations between the growth of the plants and the total concentration, the error just alluded to may be disregarded.

### RESULTS OF SERIES IV

*Appearance of the plants.*—Most of the morphological modifications of tops and roots noticed in the preceding series were also observed in series IV; but the longitudinal striping of leaves and branching from the base of the stem were not seen in this series. Root development was retarded in the higher concentrations, both primary and secondary roots being thick and short. In the lowest concentrations the roots were long, slender, and flexible in appearance. Roots in the corresponding concentrations of cultures T7R1C1, T2R4C2, and R5C2½ were about equal in development; but those in the T1R1C1 cultures were all greatly retarded. With all of the sets of salt proportions, the greenness of the plants decreased with decrease in concentration of the nutrient solution. The greenest plants were those having the T1R1C1 salt proportions; those in the R5C2½ and T2R4C2 proportions were somewhat lighter in shade, and those in the T7R1C1 proportions were much lighter. Magnesium injury was not observed in any of the T7R1C1 cultures. Only one plant in the R5C2½ cultures showed injury, this occurring in the 5.50-atmosphere concentration. Slight injury was observed in the T2R4C2 cultures in the 5.50-, 4.50-, and 2.50-atmosphere concentrations. Severe injury, with coiling of the leaves, was observed in all concentrations with the T1R1C1 salt proportions, the more severe injury appearing in the higher concentration.

*Dry weights.*—The actual dry weights of tops and of roots for this series are given in Table 15, the weights of the plants in each of the duplicate cultures and the average weights being shown. The data given in this table have been plotted as graphs in fig. 10. In these graphs abscissas represent concentration, in terms of osmotic pressure in atmospheres, and ordinates represent yields in grams. The heavy line is the graph for the T2R4C2 cultures, the light line for the T1R1C1 cultures, the dotted line for the T7R1C1 cultures, and the broken line for the R5C2½ cultures.

TABLE 15.—*Dry weights of tops and roots of wheat; for series IV, conducted from January 23 to February 24, 1917.*

| Culture No. | Osmotic concentration. | Tops (6 plants). | | | Roots (6 plants). | | |
|---|---|---|---|---|---|---|---|
| | | A. | B. | Average. | A. | B. | Average. |
| | *Atm.* | *g.* | *g.* | *g.* | *g.* | *g.* | *g.* |
| T7R1C1 | 7.0 | 0.675 | 0.582 | 0.629 | 0.210 | 0.240 | 0.225 |
| | 5.5 | 0.728 | 0.696 | 0.712 | 0.280 | 0.271 | 0.276 |
| | 4.5 | 0.788 | 0.750 | 0.769 | 0.305 | 0.301 | 0.303 |
| | 3.5 | 0.769 | 0.760 | 0.765 | 0.297 | 0.266 | 0.282 |
| | 2.5 | 0.767 | 0.699 | 0.733 | 0.271 | 0.258 | 0.265 |
| | 1.6 | 0.712 | 0.687 | 0.700 | 0.255 | 0.269 | 0.262 |
| | 1.0 | 0.828 | 0.600 | 0.714 | 0.217 | 0.216 | 0.217 |
| | 0.5 | 0.613 | 0.602 | 0.608 | 0.226 | 0.234 | 0.230 |
| T1R1C1 | 7.0 | 0.709 | 0.705 | 0.707 | 0.203 | 0.166 | 0.185 |
| | 5.5 | 0.771 | 0.740 | 0.756 | 0.205 | 0.196 | 0.201 |
| | 4.5 | 0.823 | 0.762 | 0.793 | 0.230 | 0.233 | 0.232 |
| | 3.5 | 0.823 | 0.771 | 0.797 | 0.236 | 0.249 | 0.243 |
| | 2.5 | 0.789 | 0.763 | 0.776 | 0.241 | 0.257 | 0.249 |
| | 1.6 | 0.747 | 0.722 | 0.735 | 0.257 | 0.262 | 0.260 |
| | 1.0 | 0.650 | 0.611 | 0.631 | 0.204 | 0.208 | 0.206 |
| | 0.5 | 0.642 | 0.610 | 0.626 | 0.210 | 0.207 | 0.209 |
| T2R4C2 | 7.0 | 0.776 | 0.762 | 0.769 | 0.271 | 0.273 | 0.272 |
| | 5.5 | 0.851 | 0.790 | 0.821 | 0.314 | 0.297 | 0.306 |
| | 4.5 | 0.922 | 0.885 | 0.904 | 0.329 | 0.304 | 0.317 |
| | 3.5 | 1.056 | 1.003 | 1.030 | 0.371 | 0.350 | 0.361 |
| | 2.5 | 1.164 | 1.070 | 1.117 | 0.373 | 0.356 | 0.365 |
| | 1.6 | 1.165 | 1.138 | 1.152 | 0.367 | 0.379 | 0.373 |
| | 1.0 | 0.994 | 0.900 | 0.947 | 0.305 | 0.284 | 0.295 |
| | 0.5 | 0.973 | 0.878 | 0.926 | 0.268 | 0.332 | 0.300 |
| R5C2½ | 7.0 | 0.723 | 0.642 | 0.683 | 0.226 | 0.221 | 0.224 |
| | 5.5 | 0.819 | 0.752 | 0.786 | 0.272 | 0.266 | 0.269 |
| | 4.5 | 0.963 | 0.912 | 0.938 | 0.324 | 0.305 | 0.315 |
| | 3.5 | 1.016 | 0.933 | 0.975 | 0.304 | 0.346 | 0.325 |
| | 2.5 | 1.127 | 1.123 | 1.125 | 0.350 | 0.388 | 0.369 |
| | 1.6 | 1.160 | 1.143 | 1.152 | 0.385 | 0.345 | 0.365 |
| | 1.0 | 1.013 | 0.985 | 0.999 | 0.314 | 0.293 | 0.304 |
| | 0.5 | 0.908 | 0.875 | 0.892 | 0.271 | 0.274 | 0.273 |

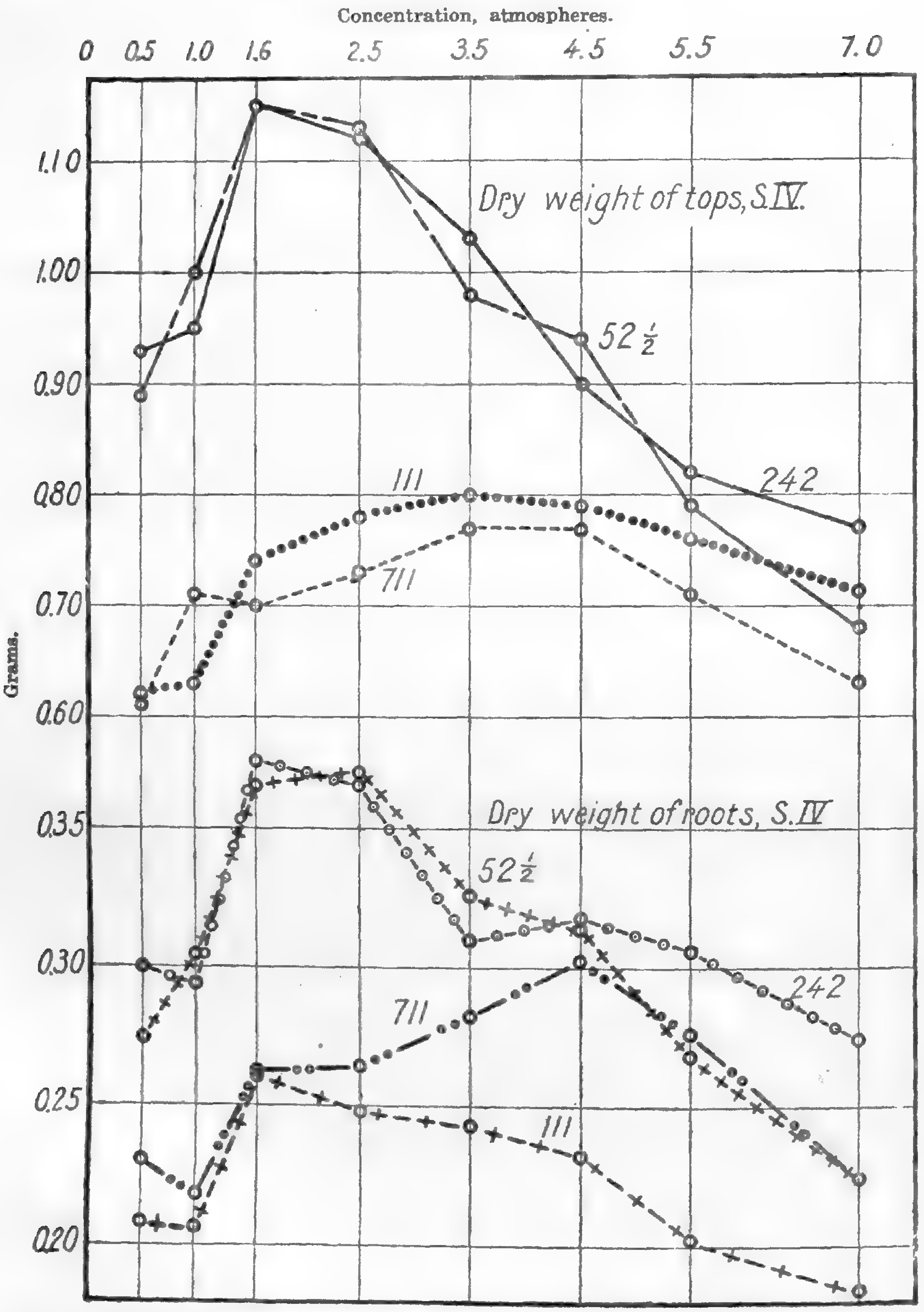


FIG. 10. Graphs of average actual yields (grams) of wheat tops and of roots for series IV.

*Water-absorption.*—The water-absorption data for this series are shown in Table 16, which corresponds in arrangement to the preceding table. These data have been plotted as graphs in fig. 11, where the method of plotting is similar to that employed in the preceding figure.

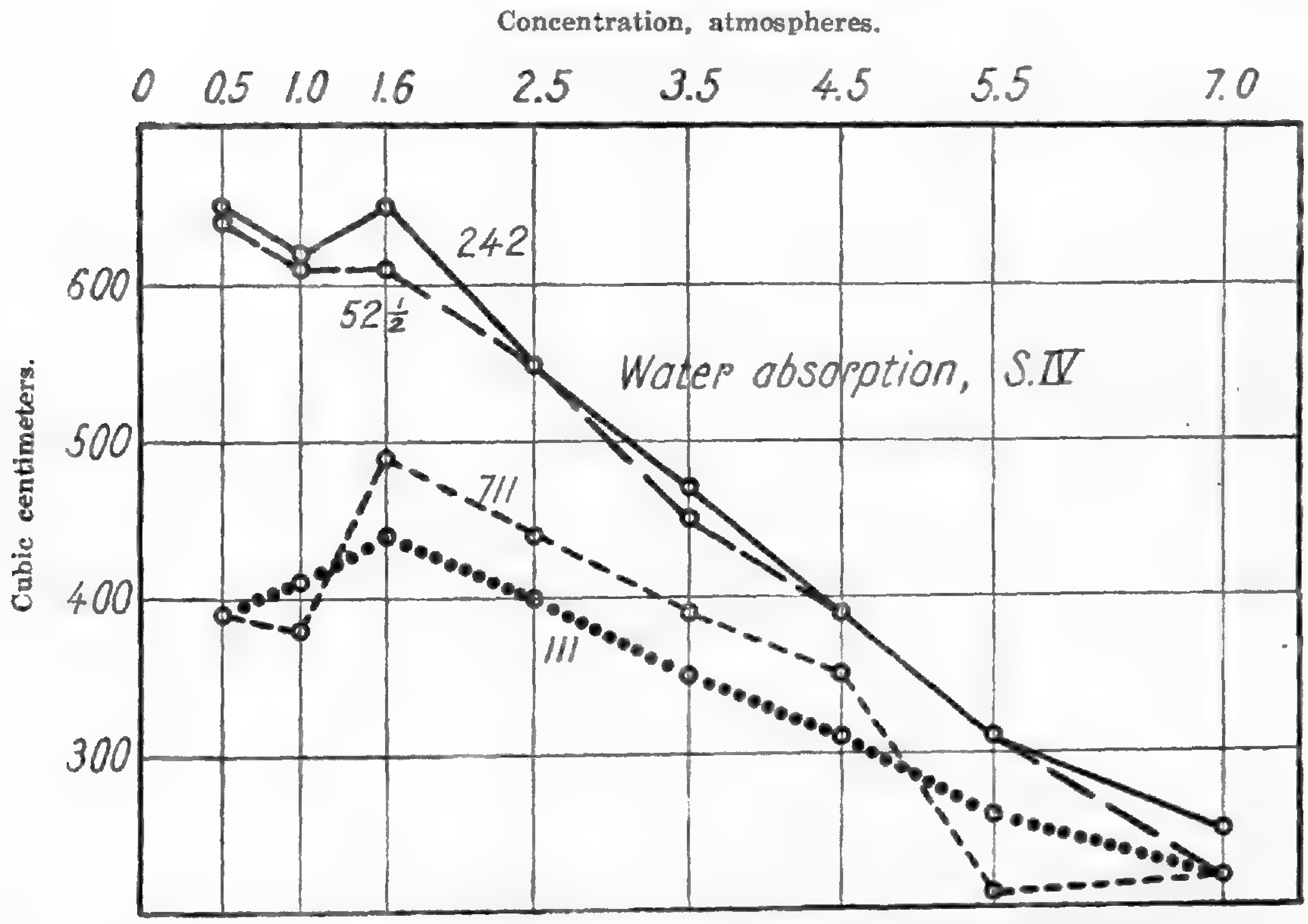


FIG. 11. Graphs of average total amounts of water absorption for series IV.

*Water requirement.*—The data of the amounts of water absorbed per unit of dry top and dry root yields are shown in Table 16. These data are plotted as graphs in fig. 12, where the method of plotting is similar to that heretofore employed for this series.

DISCUSSION OF SERIES IV

*Appearance of plants.*—In this incomplete series bearing on the relation of total concentration to the growth of the plants (it being remembered that only three of the many possible sets of salt proportions were tested) there was evidence again that the occurrence of magnesium injury is generally accompanied by a more-intense green color of the foliage. With the set of salt proportions producing greatest injury in a concentration corresponding to 1.60 atmospheres of osmotic pressure (T1R1C1), the severity of the injury as well as the number of leaves injured increased with higher total concentrations and decreased with lower. When salt proportions were employed that gave the highest dry weight with an osmotic value of 1.60 atmospheres (T2R4C2)—which did produce some magnesium injury in series I—no magnesium injury occurred with concentration values below 2.50 atmospheres, though such injury did occur with higher concentration values. The fact that aërial conditions were different from those present for series I may possibly explain why

TABLE 16.—*Water-absorption data for wheat; also, average amount of water absorbed for each gram of yield of tops and of roots (water requirement); for series IV, conducted from January 23 to February 24, 1917.*

| Culture No. | Osmotic concentration. | Water absorption. | | | Water requirement. | |
|---|---|---|---|---|---|---|
| | | A. | B. | Average. | Tops. | Roots. |
| | *Atm.* | *cc.* | *cc.* | *cc.* | *cc. per g.* | *cc. per g.* |
| T7R1C1 | 7.0 | 205 | 233 | 219 | 348 | 973 |
| | 5.5 | 304 | 289 | 297 | 417 | 1,076 |
| | 4.5 | 350 | 341 | 346 | 450 | 1,142 |
| | 3.5 | 405 | 381 | 393 | 514 | 1,394 |
| | 2.5 | 475 | 406 | 441 | 602 | 1,664 |
| | 1.6 | 488 | 487 | 488 | 697 | 1,863 |
| | 1.0 | 404 | 364 | 384 | 538 | 1,770 |
| | 0.5 | 423 | 358 | 391 | 643 | 1,700 |
| T1R1C1 | 7.0 | 228 | 215 | 222 | 314 | 1,200 |
| | 5.5 | 261 | 256 | 259 | 343 | 1,289 |
| | 4.5 | 314 | 306 | 310 | 391 | 1,386 |
| | 3.5 | 364 | 339 | 352 | 442 | 1,449 |
| | 2.5 | 405 | 394 | 400 | 516 | 1,606 |
| | 1.6 | 446 | 437 | 442 | 602 | 1,700 |
| | 1.0 | 412 | 398 | 405 | 642 | 1,966 |
| | 0.5 | 396 | 379 | 388 | 620 | 1,856 |
| T2R4C2 | 7.0 | 250 | 242 | 246 | 320 | 904 |
| | 5.5 | 315 | 306 | 311 | 379 | 1,016 |
| | 4.5 | 390 | 381 | 386 | 427 | 1,218 |
| | 3.5 | 489 | 447 | 468 | 454 | 1,296 |
| | 2.5 | 577 | 530 | 554 | 496 | 1,518 |
| | 1.6 | 660 | 632 | 646 | 560 | 1,732 |
| | 1.0 | 638 | 597 | 618 | 652 | 2,095 |
| | 0.5 | 620 | 682 | 651 | 703 | 2,170 |
| R5C2½ | 7.0 | 224 | 223 | 224 | 328 | 1,000 |
| | 5.5 | 316 | 305 | 311 | 396 | 1,156 |
| | 4.5 | 402 | 370 | 386 | 412 | 1,225 |
| | 3.5 | 469 | 424 | 447 | 459 | 1,375 |
| | 2.5 | 555 | 536 | 546 | 485 | 1,480 |
| | 1.6 | 617 | 611 | 614 | 533 | 1,682 |
| | 1.0 | 622 | 596 | 609 | 610 | 2,003 |
| | 0.5 | 655 | 620 | 638 | 715 | 2,337 |

this injury was not apparent with these proportions with a concentration value of 1.60 atmospheres, for which injury was observed in series I. At any rate, these results indicate that magnesium injury is not to be expected with the lower concentrations of this set of salt proportions, but that it is to be expected with higher concentrations. With the other four-salt mixture here tested (T7R1C1, having the highest content of potassium chloride of all the original eighty-four solutions) no magnesium

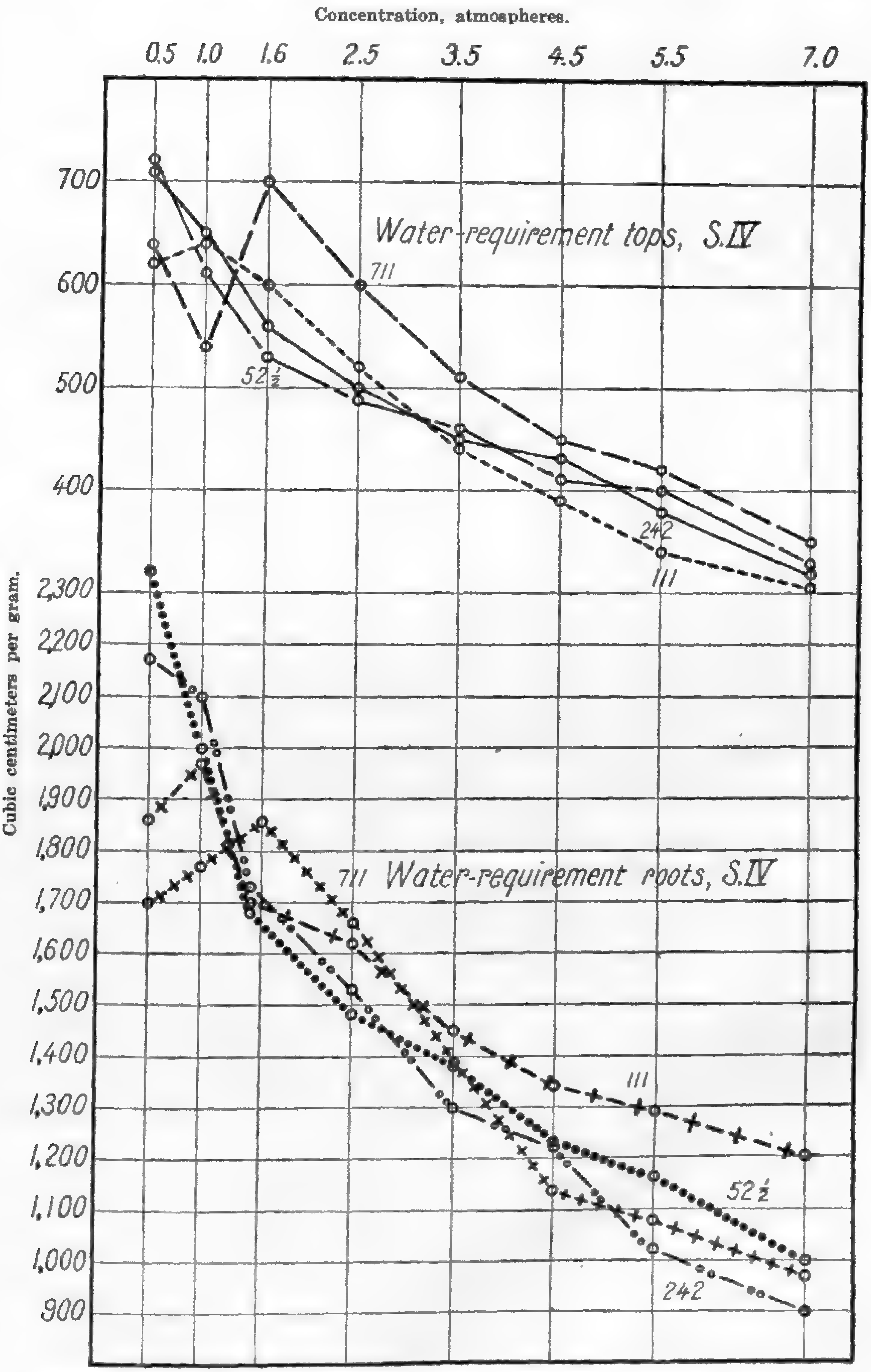


FIG. 12. Graphs of average water requirement of tops and of roots for series IV.

injury occurred, although it did occur in series I with this set of salt proportions for a total concentration corresponding to 1.60 atmospheres. It is clear that magnesium injury does not increase with total concentration with this set of salt proportions. The fourth set of salt proportions tested in this series (R5C2½ on the Shive diagram, which resembled very closely Shive's best solution) showed no magnesium injury in any of these concentrations, except a slight indication with a concentration value of 5.50 atmospheres, although Shive's best solution regularly produces this form of injury. It is to be noted that while this set of salt proportions differed from that of Shive's best solution to only a small degree, yet this difference was in such a direction as to justify an expectation of less magnesium injury than occurred in the Shive solution. It appears that solution R5C2½ lies on the border line where more or less marked magnesium injury may or may not occur, according to conditions so far uncontrolled, such as those of the climate or the susceptibility of the individual plants.

*Dry weights.*—The top yields of this series (fig. 10) bring out what appear to be some very important considerations. With the set of salt proportions (T2R4C2) giving highest yields in series I a concentration value of 1.60 atmospheres, or perhaps somewhat higher, appears to be optimal for dry yield of tops. Both lower and higher concentrations give lower yields. With concentrations below this optimum, the yield falls off much more rapidly than with those above. It is especially interesting to note that a total concentration value of 0.50 atmosphere nearly corresponds in top yield with a total concentration value of 4.50 atmospheres. Lower total concentrations than the lowest here employed (0.50 atmosphere) would doubtless have given still lower dry weight values, but it is not to be expected that the latter would have been reduced very much in this way. It is noticeable, on the other hand, that the low top yield occurring with the highest concentration here used (7.00 atmospheres) is much lower than that occurring with a concentration value of 0.50 atmosphere. The three-salt mixture of this series (R5C2½, on the Shive triangle) agreed very well in all particulars with solution T2R4C2. The graph of this set of three-salt proportions may be regarded as indicating what would have been obtained if Shive's set of salt proportions had actually been used. On the basis of this supposition, and on that of the data here given for solution T2R4C2, it is not to be expected that either this four-salt solution with chloride, or the Shive three-salt solution without chloride, can be significantly improved for the production of top yield under these general conditions by altering the total concentration. As has been mentioned, it is possible that the yield might have been a little higher had the total concentration been slightly increased. But it is safe to regard a concentration value of 1.60 or 1.75 atmospheres as optimum for both sets of salt proportions, under the aërial conditions furnished by the greenhouse used in this study, and with the plants and frequency of solution renewal employed.

The two other four-salt proportions included in this series (T1R1C1 and T7R1C1), both of which gave very low top yields with a total concentration value of 1.60 atmospheres in series I and II, here show their highest top yields with a concentration value of 3.50 atmospheres and 4.50 atmospheres, respectively. As in the case just discussed, concentrations below and above the optimum show much lower yields. The two graphs are seen to be nearly parallel throughout. Their form differs from that of the other two graphs of this series, not only in position of the maximum but also in the fact that they are nearly symmetrical about the maximum. Both are rather flat-topped.

While root yields (fig. 10) agree in a general way with top yields as related to the total concentration of the nutrient solution, some rather marked differences occur in other respects. It will be noticed that both the heights of the graphs, indicating actual yields, and the forms of the graphs, showing the relation of changes in concentration to changes in yield, differ for the four sets of salt proportions tested. The graph for the T2R4C2 cultures shows that maximum root yields were obtained with a concentration of 1.60 atmospheres, from which it appears that this solution cannot be significantly improved for root production by changing its total concentration from 1.60 atmospheres. It will be observed, however, that solution R5C2½, which had no chloride and resembled Shive's best solution for tops, gave a slightly higher root yield with a concentration of 2.50 atmospheres than with one of 1.60 atmospheres. The difference, however, is small. With the two concentrations higher than 4.50 atmospheres root yields were significantly higher with the solution containing the chloride (T2R4C2) than with the one that lacked it (R5C2½). Apparently, high total concentrations are less injurious to roots in the presence of the chloride than in its absence. The graph for culture T7R1C1 (having 0.7 of its concentration due to potassium chloride) is very different in form from those just considered. This graph exhibits a marked maximum at 4.50 atmospheres, instead of at 1.60 or 2.50 atmospheres. The fourth graph, that for the T1R1C1 cultures, having 0.7 of their total concentration due to magnesium sulphate and 0.1 due to each of the other three salts, resembles the first two graphs much more closely than it does the third. With these solutions having very high proportions of magnesium sulphate, the optimum concentration was 1.60 atmospheres, and the yields decreased rather slowly with increasing concentrations above that value. Very high total concentrations retarded root production much less when the solution had high proportions of potassium chloride than when it had high proportions of magnesium sulphate.

This series furnishes very conclusive proof of the point already brought out by Shive and Tottingham; namely, that the optimum total concentration may be expected to vary with the sets of salt proportions used, and that for any total concentration an optimal set of salt proportions may be found. There appears to be no such thing as an optimal total concentration without reference to the salts and salt proportions used, and there is no optimal set of salt proportions except for some specific range of total concentrations.

*Water absorption.*—The most striking feature of the graphs shown in fig. 11 is the nearly linear decrease in total water absorption with an increase in concentration between the limits 1.60 and 7.00 atmospheres. It will be observed that the graph for the T2R4C2 cultures tends to parallel and lie slightly above that for the R5C2½ cultures. The graph for the T7R1C1 cultures (which have 0.7 of their concentration due to potassium chloride) lies considerably below these two and tends to parallel but remain above that for the T1R1C1 cultures (having 0.7 of their concentration due to magnesium sulphate).

The graphs for the T2R4C2 and the R5C2½ cultures are irregular below 1.60 atmospheres. The R5C2½ cultures, it will be remembered, have no potassium chloride but otherwise are approximately the same in composition as the T2R4C2 ones. It is impossible to determine from these graphs what concentration may be expected to give maximum water absorption, because the values for 0.50, 1.00, and 1.60 atmospheres are so nearly alike. But a markedly lower absorption is evident for concentrations higher than 1.60 atmospheres. Both graphs show an approximately linear decrease in water absorption with an increase in concentration, between the limits 1.60 and 7.00 atmospheres. The omission of potassium chloride did not alter the relationship between concentration and absorption for concentrations lying between these limits.

The graphs for the T7R1C1 cultures and the T1R1C1 cultures both show perfectly definite maxima at 1.60 atmospheres. Above this concentration, water absorption bears an approximately linear relationship to concentration.

The most interesting portions of all of these graphs are those between the concentrations 1.60 and 7.00 atmospheres. It will be seen that the slopes of the T2R4C2 and R5C2½ graphs are about the same. But the slopes of the T7R1C1 and T1R1C1 graphs are much less steep. Thus changes in concentration in the T7R1C1 and T1R1C1 sets of proportions (both of which were unfavorable media at all concentrations) produced much less marked changes in water absorption than did similar changes in the very favorable T2R4C2 and R5C2½ solutions.

By comparing figs. 10 and 11 it will be seen that for cultures T2R4C2 and R5C2½, between 1.60 and 7.00 atmospheres at least, water absorption is a good measure of top yield, and appears to depend principally upon the size of the plants. But for the T7R1C1 and T1R1C1 cultures, water absorption does not vary in the same way as do top yields. In both of these sets of cultures absorption decreases with increasing concentration between 1.60 and 7.00 atmospheres, while dry weight of tops increases with concentrations of from 1.60 to 3.50 (for T7R1C1) and to 4.50 (for T1R1C1) atmospheres and then decreases. Thus, as the concentration changes from 1.60 to 3.50 or 4.50 atmospheres, top yields increase while water absorption decreases. The difference in amount of water absorbed in this case is not at all a measure of the change in dry weight.

*Water requirement.*—As shown in fig. 12, a decrease in water requirement of tops accompanies an increase in the concentration of the culture medium. This is true for the T2R4C2 and R5C2½ cultures throughout the whole range of concentrations studied; while for the T1R1C1 cultures it holds only between 1.00 and 7.00 atmospheres, and for the T7R1C1 cultures only between 1.60 and 7.00 atmospheres. This decrease approximates in most cases a straight line; though, for a given change in concentration, there is apparently a more rapid decrease in water requirement with the lower concentrations than with the higher. This is especially marked for the T2R4C2 and R5C2½ cultures, between the concentrations 0.50 and 1.60 atmospheres.

For concentrations above 1.60 atmospheres the T7R1C1 graph lies above the other three for all concentrations. The water requirement for these cultures, which are very high in chloride, is thus higher than for the other three sets for all concentrations between these limits. The graphs for the other three sets of salt proportions lie very close together, and cross one another frequently, so that there appear to be no significant differences between them.

If equal dry weights in different cultures corresponded to equal leaf areas, then the water requirement would of course give an approximate measure of the transpiring power per unit area of leaf surface; that is, of the ability of a unit area of leaf surface to give off water by transpiration.[52] It is of course not to be expected that equal dry weights do correspond at all rigidly to equal leaf areas, and hence the use of water requirement as a measure of transpiring power would be only a rough approximation at best. But the relations that have been observed in these studies between concentration and water requirement are likely to be approximately the same as those between concentration and transpiring power of unit leaf area. Transpiring power might be expected to decrease, in the way represented by the graphs, with increasing osmotic concentration of the medium surrounding the roots. Transpiring power, for the whole plant, is taken to be practically identical with water-absorbing power, measured by total water absorption.

The graphs for the water requirement of roots (fig. 12) show the same general features as those already described for tops. There is a general decrease in the water requirement of roots with an increase in concentration of the culture medium. The graphs frequently cross, and all have about the same slope, though above 3.50 atmospheres the T1R1C1 graph falls less rapidly than do the others.

The water requirements of roots may be taken as an approximation of the water-absorbing power of the roots per unit root weight and also of their absorbing power per unit area of root surface. This is seen to decrease with an increase in the osmotic concentration of the medium surrounding the roots, as might be expected on physico-chemical grounds.

[52] Livingston, B. E., The resistance offered by leaves to transpirational water lost, Plant World **16** (1913) 1–35. Livingston, B. E., and Hawkins, Lon A., The water-relation between plant and soil, Publication Carnegie Inst. Washington **204** (1915) 5–48.

## GENERAL CONCLUSIONS

A mass of experimental data such as is furnished by the present study suggests a very large number of questions and interpretations pertaining to the numerous details of the results. But it is desirable that the first analysis of these results should refer to none but the more broadly general problems. Only these general relations have been included in this study and, of these, those pertaining to the appearance of the plants and the dry yields have received principal attention in this discussion.

It appears that the growth of these wheat plants for twenty-four days was nearly the same, whether a nutrient solution containing (1) Tottigham's four salts, (2) Shive's three salts, or (3) the latter with potassium chloride was employed, provided the set of salt proportions giving the best growth was selected in each case. These three types of solutions appear to have been equally efficient for promoting the growth of the plants. The four-salt solution with potassium chloride apparently offers no advantages or disadvantages, as compared with either of the mixtures previously studied systematically. It was found that the presence of potassium chloride exerted no marked influence, at least for the total concentration principally studied (1.60 atmospheres), when the four salts were used in the proportions giving highest top yields; and the best four-salt solution with potassium chloride contains the other three salts in nearly the same relative proportions as those in which the same salts occur in Shive's best three-salt solution of the same total concentration.

No injurious or retarding effect was observed that could be definitely ascribed to high partial concentrations of potassium chloride, even when this salt made up 0.9 of the osmotic value of the solution; and no characteristic injury was seen that could with certainty be related to the chloride. Retardation of growth associated with high chloride content of the culture solution appeared to be due to the accompanying low concentrations of the other three salts rather than to high partial concentration of the chloride. It is possible that a rather pronounced chlorosis may have been related to a high chloride content of the solution, but the evidence is not definite upon this point.

While it seemed to be impossible to obtain better growth of these plants in the four-salt solution containing potassium chloride than in Shive's best three-salt solution, there is some evidence, nevertheless, that poorly balanced proportions of Shive's three salts may have been improved for the growth of the plants, especially with reference to root yields, by the addition to the solution of a proper amount of potassium chloride.

Since the wheat plant is not very sensitive to changes in concentration of potassium chloride, the osmotic value of the solution must be changed when potassium chloride is added in large enough amounts to cause a physiological response. If the nutrient solution is to remain the same in total osmotic value, the concentrations of the other three salts must be decreased when potassium chloride is added to give high partial concentrations. It is impossible to decide whether such plant responses as are thus obtained are due to the high partial concentration of the chloride or to the low partial concentrations of the three other salts. This dilemma was always encountered in seeking to obtain evidence on the points just mentioned, and this whole general problem is too complicated to treat experimentally.

It is also difficult to interpret the results in such a way as to determine the action of the chlorine ion (Cl), as such. The problem is complicated by the fact that additions of the chlorine ion to the nutrient solution were always accompanied by equal additions of the potassium ion. It is possible that such additions of the potassium ion may have modified any effects of the chlorine ion that might have been observed under other conditions.

Data on root development are never so easily interpreted as are those on the development of tops in such plants as wheat, a difficulty experienced also in the present study. But effects upon the root system are of especial physiological importance, because this is the part of the plant that is in immediate contact with the culture solution, and it is through the roots that all the water and salts absorbed by the plant must enter. It appears to have been true, in a general way at least, that those salt proportions of the four-salt solution with chloride that gave high top yields also gave high root yields. Conversely, salt proportions giving low top yields generally gave low root yields also. This statement is the opposite of the one given by Shive, based upon his studies with the three-salt solutions. It is possible that the addition of the chlorine ion to the ones already present in the three-salt solution, or some special influence of potassium chloride, may account for this difference. The general indefiniteness, however, of the root data makes superfluous a further discussion of this point without further experimentation.

Certain of the sets of salt proportions with chloride produced a characteristic form of leaf injury, which was observed in

Tottingham's and in Shive's studies, and has been termed "magnesium injury" by Tottingham. The plants giving lowest yields in all three studies exhibited this form of injury, and all three studies support the conclusion that the occurrence and severity of this injury is related to the ionic ratio of magnesium to calcium in the culture solution. This is the only case brought out by any of these three studies (Tottingham's, Shive's, and the present one) in which a clear relation may be regarded as demonstrated between the value of an ionic ratio and the development of the plant. The occurrence of this injury was, in general, not altered by the presence in the solution of potassium chloride, except perhaps with very high proportions of that salt. In the present study the greenness of the foliage was roughly proportional to the severity of the injury, the color being darkest green in the most severely injured plants. Only two sets of salt proportions producing this injury were tested with total concentrations other than the one generally employed in this study; but these agreed in showing that both severity of injury and intensity of color increased with increase in the osmotic value of the solution. The plants in the most dilute solution (0.50 atmosphere) were markedly chlorotic.

The occurrence of magnesium injury is apparently limited, as has been stated, by the value of the Mg/Ca-ratio. With solutions having an osmotic value of 1.60 atmospheres this injury is to be looked for, under the conditions of the present study, when the value of the ratio Mg/Ca is greater than 1.70. Also, the plants may be expected to be without this injury when this ratio value is below 0.80. Since neither Shive nor Tottingham detected any injured plants in their series of lowest concentrations, and since in series IV of the present study injury was found to increase with increase in concentration, it may be expected that these approximate limits will differ with difference in the total concentration.

The solution giving highest top yields with a total osmotic value of 1.60 atmospheres (T2R4C2) contained the four salts in the following partial volume-molecular concentrations: 0.0047 M calcium nitrate, 0.0138 M monopotassium phosphate, 0.0081 M magnesium sulphate, and 0.0067 M potassium chloride. This solution is not very different from what would be obtained by diluting Shive's best solution for wheat to an osmotic value of 1.28 atmospheres, and then adding sufficient potassium chloride to give a partial volume-molecular concentration of this salt of 0,0067 M. Shive's best solution contains the other three salts in the following partial volume-molecular concentrations: 0.0052 M calcium nitrate, 0.0180 M monopotassium phosphate, and 0.0150 M magnesium sulphate. The two solutions differ in the value of the Mg/Ca-ratio, which in Shive's solution has a value of 2.88, while in the four-salt solution with chlorine it has a value of only 1.72. As would be expected from this difference in the Mg/Ca-ratios, magnesium injury was less pronounced in the four-salt solution than in Shive's best solution. The best solution with chloride for tops has quite different salt proportions from Tottingham's best four-salt solution without chloride, which has potassium nitrate instead of potassium chloride and has a higher partial concentration of calcium nitrate.

The four salts used by Tottingham (potassium nitrate, magnesium sulphate, calcium nitrate, and monopotassium phosphate) are the same as are employed in the solution generally called Knop's solution, and the three salts used by Shive (magnesium sulphate, calcium nitrate, and monopotassium phosphate) are those used in the Birner and Lucanus solution. Likewise, the four salts used in the present study are the same as those of the solution that has come to be known as Detmer's, which contains the four salts in the following volume-molecular proportions: 0.0130 M calcium nitrate, 0.0039 M monopotassium phosphate, 0.0044 M magnesium sulphate, and 0.0072 M potassium chloride. In the case of each of the three solutions, it has been found that the well-known solution could be markedly improved for the growth of wheat by altering the salt proportions. As indicated in the present study, Detmer's solution may be expected to give only about 0.80 as high top yields as does solution T2R4C2. It is important to note that at least thirty out of the eighty-four different sets of salt proportions employed in the first series of this study gave higher yields than the one indicated for the Detmer proportions.

It is worthy of particular attention that, with an osmotic value of 1.60 atmospheres or higher, the Shive three-salt mixture produced magnesium injury when the salt proportions were such as to give the highest yield of tops. This was also true of the four-salt mixture of the present study in the first series; but the solution giving highest top yields did not exhibit this injury in the second series. It has been suggested that increased growth is the first response to agents or circumstances which would prove injuriously toxic in greater concentration or on longer exposure; in other words, that slight poisoning, such as is caused by magnesium, is essential for the greatest dry weight of tops.[53] The problem thus suggested will not be discussed here, but it is important to consider what salt proportions may be expected to give the highest top yields without magnesium injury. The results of the first two series indicate that either solution T3R3C3 or T2R3½C3½ may fulfill these requirements. An examination of Shive's data makes it appear that his solution R7C2, having an osmotic value of 1.75 atmospheres, should produce highest top yield without magnesium injury. The various characteristics of the solutions just mentioned are brought together for comparison in Table 17.

From a study of the osmotic properties of the nutrient solution, as distinguished from its chemical properties, it was found that the optimum concentration for the yield of tops corresponded to an osmotic pressure of about 1.60 atmospheres, at 25° C., when the salt proportions were those of solution T2R4C2. The indications are that for these salt proportions the optimum concentration may be somewhat higher than 1.60 atmospheres, rather than lower. From the results of the present study this statement is true also for a three-salt mixture which would be designated on Shive's composition triangles as R5C2½ and which, therefore, very closely resembles his best three-salt solution for wheat tops.

The optimum concentration was found to be markedly higher for two other sets of salt proportions of the four-salt solution used in this study. The osmotic value was 3.50 atmospheres for solution T1R1C1 and 4.50 atmospheres for solution T7R1C1. These two solutions had salt proportions that gave relatively low top yields, and the yields from their optimal concentrations were very much lower than those obtained from the optimal concentration of solution T2R4C2, which had the best proportions for top yield. It may be tentatively concluded that solution T2R4C2 with an osmotic value of 1.60 atmospheres, or perhaps a little higher, is about the absolute optimum for these four salts, for the frequency of solution renewal and for the plants employed, and for the general greenhouse conditions and length of growing period of the present study.

It seems worth while to lay stress upon some of the prominent considerations that must be constantly borne in mind in trying

[53] Free, E. E., and Trelease, S. F., The effects of certain mineral poisons on young wheat plants in three-salt nutrient solutions, Johns Hopkins Circular N. S. No. 3 (March, 1917) 199–201.

TABLE 17.—*Characteristics of the four-salt solution with chloride giving highest yield of tops, and of various other solutions that are of comparative interest.*

| Designation of solution. | Salt proportion. | | | | | | | | | | Cation-ratio value. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Ca(NO_3)_2$ per liter. | | $KH_2PO_4$ per liter. | | $MgSO_4$ per liter. | | KCl per liter. | | $KNO_3$ per liter. | | Mg/Ca. | Mg/K. | Ca/K. |
| Four-salt solutions with KCl (1.6 atmospheres): | *g. mol.* | *g.* | *g. mol.* | *g.* | *g. mol.* | *g.* | *g. mol.* | *g.* | *g. mol.* | *g.* | | | |
| Best for wheat tops (T2R4C2) | 0.0047 | 0.771 | 0.0138 | 1.879 | 0.0081 | 0.975 | 0.0067 | 0.450 | | | 1.72 | 0.40 | 0.23 |
| Best for wheat tops without magnesium injury, Series I (T3R3C3) | 0.0072 | 1.181 | 0.0103 | 1.402 | 0.0038 | 0.457 | 0.0101 | 0.753 | | | 0.53 | 0.19 | 0.35 |
| Series II (T2R3.5C3.5) | 0.0085 | 1.395 | 0.0121 | 1.647 | 0.0038 | 0.457 | 0.0067 | 0.450 | | | 0.45 | 0.20 | 0.45 |
| Detmer (T2.16R1.20C5.47) | 0.0130 | 2.132 | 0.0039 | 0.532 | 0.0044 | 0.532 | 0.0072 | 0.532 | | | 0.34 | 0.40 | 1.17 |
| Three-salt solutions (1.75 atmospheres) (Shive): | | | | | | | | | | | | | |
| Best for wheat tops (R5C2) | 0.00523 | 0.853 | 0.0180 | 2.451 | 0.0150 | 1.806 | | | | | 2.88 | 0.83 | 0.29 |
| Best for wheat tops without magnesium injury (R7C2) | 0.0052 | 0.853 | 0.0252 | 3.431 | 0.0050 | 0.602 | | | | | 0.96 | 0.20 | 0.20 |
| Four-salt solution (1.75 atmospheres) (Tottingham): | | | | | | | | | | | | | |
| Best for wheat tops (T3R1C4) | 0.0101 | 1.657 | 0.0109 | 1.484 | 0.0081 | 0.975 | | | 0.0034 | 0.0344 | 0.80 | 0.57 | 0.71 |

to interpret the experimental results furnished by this study. The growth and development of a particular set of culture plants is, of course, controlled by the environment, which comprises a large number of different kinds of effective conditions. An attempt was made in these experiments to control only a small number of the conditions that may influence the plant. Of these effective conditions of the environment, only the initial concentration (osmotic value), the initial salt content of the solution, the frequency of renewal of the latter, and the duration of the experiment were controlled and taken into account. Other conditions that might act upon the plants and might alter the influence of the controlled conditions were allowed to vary as they did in the experiment greenhouse, without being taken into account at all. Among such uncontrolled conditions may be mentioned, for illustration, the temperature of the nutrient solution and of the air around the foliage, the composition of this air, the radiation, etc.

Since it is apparent that no solution remains unaltered after the introduction of the plants, the frequency of renewal of the nutrient solution must be considered a very important environmental condition. It is well known that the absolute plant values may be greatly changed by altering the frequency of renewal of the solution, and with any other frequency of renewal than the one employed in these experiments the comparative results might have been very different from those recorded in this paper. Other changes in the comparative plant values might have been induced by aërating the culture solutions. The temperature of the culture solution also must have an important effect upon the comparative plant values. With other solution temperatures than those employed, the comparative values obtained might have been very different from those that were obtained in these studies.

It appears probable that any given set of solution conditions may produce very different effects upon the plant according to the kinds and intensities of the conditions other than the solution that are effective. If two duplicate series of different sets of salt proportions or of different total concentrations of the nutrient solution were carried out, one with higher air temperature or with more sunshine than the other, it might well happen that the comparative plant values obtained from one series might be very different from those obtained from the other. It seems possible, for example, that lower optimal concentrations might have been obtained in series IV under aërial conditions that favored higher rates of transpiration. It may be added that the length of the period during which the plants are exposed to the environmental conditions is unquestionably very important in determining the nature of such results as were obtained in the present study. In consequence of these considerations, it is evident that conclusions drawn from this study can be regarded as applicable only for nonsolution conditions that are not greatly different from those encountered in these experiments. As has been mentioned, these conditions were, in a general way, those of a greenhouse in the winter and spring in the temperate region.

Aside from the conditions of environment there is of course another set of conditions that is very influential in determining plant activities. This is the group of internal conditions, which are effective from within the plant body itself. All that can be done toward the control of these internal conditions must be accomplished either by employing for the experiments plants that are as nearly alike internally as possible, or by subjecting the available plants to thoroughly controlled environments for an adequate period to make them alike. In this work, as in most experimentation of this kind, considerable care was exercised to employ plants, for the different cultures of any series, that were very nearly alike in size and general appearance. This method is clearly not entirely satisfactory, but it is about as good as the present state of our knowledge permits. Of course it is evident, just as in the case of the environmental conditions, that the conclusions of this study can be interpreted only with reference to the particular, initial, internal conditions of the plants used. It is not to be expected that the results would have been quite the same if some other species or variety of plant had been used, or if the plants had been introduced into the experiments at a different stage of their development.

While the somewhat complicated considerations just expressed may make such problems as those dealt with in this study seem very difficult, or even practically impossible of solution, from our present point of view, yet, physiological progress seems to lie in the accumulation of such partial answers to these questions as may be obtained experimentally, and in the careful correlation of these partial answers as they become available. It was with this idea in mind that the study here reported was carried out.

# ILLUSTRATIONS

# A NEW GENUS OF MYRSINACEAE FROM THE PHILIPPINES

By Elmer D. Merrill
*Director and Botanist, Bureau of Science, Manila*

## APOIA genus novum

Flores hermaphroditi, 5-meri. Sepala imbricata, usque ad ½ connata, subcoriacea, epunctata. Petala usque ad ¼ connata, imbricata, per anthesin patentia, epunctata. Antherae 5, disco petalis adnato insidentes, quam petalis multo breviores, basifixae, rimis longitudinaliter subintrorsae dehiscentes, staminodeis brevibus alternantibus. Ovarium glabrum, ovoideum, 2-loculare, loculis 1-ovulatis, ovulis a basi erectis; stylo cylindrico, brevi. Fructus ellipsoideus, baccatus, breviter mucronatus, 2- vel 1-spermus. Semen ellipsoideum vel plano-convexum, albumine laevi, endocarpio crustaceo. Arbor glabra, epunctata, foliis alternis, integris vel leviter undulatis, petiolatis, glabris, petiolo apice 1- vel 2-appendiculato-glanduloso. Inflorescentiae axillares, paniculatae, multiflorae, flores spicatim dispositae, bracteolatae.

**APOIA MACROCARPA** (Elm.) comb. nov.

*Discocalyx macrocarpa* (Elm.) Leafl. Philip. Bot. 8 (1915) 2781.

The form described by Elmer as *Discocalyx macrocarpa* is represented by three collections from Mount Apo, Davao District, Mindanao, *Elmer 11867, 10660, 10553,* of which two are in flower and one is in fruit. The species occurs in primary forests at altitudes from 750 to 1,100 meters, and is locally known to the Bagobos as *pamaluyan.*

The original description is very long, yet several very important characters are not mentioned, these being the presence of staminodes alternating with the stamens; the 2-celled ovary, each cell with a single basal ovule; and the often 2-seeded fruit. The peculiar appendiculate-glandular petiole character is mentioned although this is not emphasized. At the junction with the lamina each petiole is provided with one, or more usually two, rather stout, spreading or subappressed, appendaged glands, these often being 1 mm or more in length.

I do not consider that the species can possibly be placed in *Discocalyx,* and it is so anomalous in the Myrsinaceae that I am by no means certain that it really belongs in this family, although in spite of its anomalous characters it seems to be better placed here than in any other group. The entire absence of the punctate glands in the vegetative and floral organs; its 2-celled ovary, each cell with a single basal ovule; its ellipsoid, 2- or, by abortion, 1-seeded fruits; and its appendiculate-glandular petioles are anomalous characters in the Myrsinaceae, while staminodes are rare in the group, being confined to the quite unallied genus *Rapanea.* If it is properly placed in the Myrsinaceae, it is probably as close to *Discocalyx* as to any other proposed genus.

# LOW-SUN PHENOMENA IN LUZON

## III. MARINE SUNSETS AND THE DURATION OF SUNSET ON MANILA BAY AND THE CHINA SEA

By WILLARD J. FISHER

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In as much as the sun's upper limb might be supposed to descend at end of sunset to the level occupied at beginning by the lower limb, one would expect the duration of sunset over a water horizon to be unaffected by atmospheric refraction. If this were the case, the duration could be computed from Nautical Almanac data, and would depend only on the observer's latitude and altitude, and the declination of the sun. Having accidentally found that the observed duration was in one case greater than the computed by an amount not to be laid to errors of observation, I have been interested to follow the matter further.

In the astronomical triangle *PZS*, whose sides are complement of latitude $90° - \psi$, complement of declination $90° - \delta$, complement of altitude $90° - h$,

$$\sin h = \sin \psi \sin \delta + \cos \psi \cos \delta \cos P.$$

If in this we take $\psi$ and $\delta$ constant and differentiate, we have

$$dP = \frac{-4 \cos h \, dh}{\cos \psi \cos \delta \sin P}.$$

If $dh$ is in arc minutes, the factor 4 gives $dP$ in time seconds. In our problem, $dh$ is the angular diameter of the sun; $dP$ is the duration of sunset; $h$ is the angular elevation of the sun's center at midsunset, and may be got from the height of the eye and horizontal refraction; it is so small that its cosine is nearly equal to 1, and so $h$ need not be known very accurately; $P$ is the sun's hour angle at midsunset, computed from Nautical Almanac data or observed; for all the sunsets observed $P$ is not far from 90°, and its sine is insensitive to small errors; $\phi$ and $\varsigma$ are supposed accurately known.

Table 1, with explanatory notes, shows the results obtained during December, January, and April, 1918, 1919, and 1920, at Manila, at San Fernando, La Union, and in Benguet, computed with four place logarithms.

TABLE 1.

| No. | Date. | Duration. Observed. | Duration. Computed. | Duration. Difference. | Mirage. | Type. | Contacts. 1 | Contacts. 2 | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | 1918 | *Seconds.* | *Seconds.* | *Seconds.* | | | | | |
| 1 | Dec. 22 | 159.8 | 147.45 | +12.4 | ------ | B | ------ | ------ | |
| | 1919 | | | | | | | | |
| 2 | Jan. | 145.5 | 146.6 | − 1.1 | 1 | ------ | ------ | ------ | |
| 3 | Jan. 10 | 156.5 | 146.1 | +10.4 | 0 | B | ------ | ------ | Colton phenomena. |
| 4 | Jan. 11 | 164.0 | 145.7 | +18.3 | ------ | B | ------ | ------ | |
| 5 | Jan. 18 | 148.0 | 144.3 | + 3.7 | ------ | ------ | ------ | ------ | Harbor breakwater as horizon. |
| 6 | Jan. 22 | 147.0 | 143.6 | + 3.4 | 0 | ------ | ------ | ------ | |
| 7 | Jan. 23 | 146.0 | 143.4 | + 2.6 | 0 | ------ | ------ | ------ | |
| 8 | Jan. 24 | 169.0 | 143.2 | +25.8 | 0 | B | ------ | ------ | |
| 9 | Jan. 25 | 163.0 | 143.0 | +20.0 | 0 | ------ | 1 ? | ------ | |
| 10 | Jan. 27 | 153.0 | 142.4 | +10.6 | 0 | B | ------ | ------ | Colton phenomena. |
| 11 | Jan. 29 | 150.5 | 141.9 | + 8.6 | 0 | B | ------ | ------ | Do. |
| 12 | Jan. 31 | 152.0 | 141.4 | +10.6 | 0 | B | ------ | ------ | Colton phenomena weak. |
| 13 | Apr. 16 | 133.0 | 134.7 | − 1.7 | ? | A | 1 ? | ------ | Mount Mirador. Colton phenomena. |
| 14 | Apr. 18 | 136.5 | 134.8 | + 1.7 | ------ | A | ------ | ------ | Mount Mirador. Colton phenomena strong. |
| 15 | Apr. 19 | 136.0 | 135.0 | + 1.0 | ------ | ? | 1 ? | ------ | Do. |
| 16 | Apr. 20 | 158.0 | 134.9 | +23.1 | ------ | ? | 1 ? | ------ | Mount Mirador. Colton phenomena. |
| 17 | Apr. 21 | 136.0 | 136.2 | − 0.2 | ------ | A | ------ | b | San Fernando. |
| 18 | Dec. 9 | 145.8 | 148.6 | − 2.8 | 0 | ------ | ------ | ------ | |
| 19 | Dec. 12 | 147.1 | 148.9 | − 1.8 | 0 | A | ------ | ------ | |
| | 1920 | | | | | | | | |
| 20 | Jan. 8 | 159.0 | 148.5 | +10.5 | 0 | ------ | ------ | ------ | Slight rain. |
| 21 | Jan. 12 | 150.2 | 145.8 | + 4.4 | 0 | ------ | a | a | |
| 22 | Jan. 18 | 148.5 | 144.4 | + 4.1 | 0 | B | a | a 1 | |
| 23 | Jan. 20 | 143.6 | 144.0 | − 0.4 | 0 | ------ | a | a | Colton phenomena weak. |
| 24 | Jan. 21 | 141.7 | 143.9 | − 2.2 | 2 | A | b | ------ | Colton phenomena marked. |
| 25 | Jan. 22 | 142.3 | 143.6 | − 1.3 | 0 | A | a | a | |
| 26 | Jan. 23 | 143.0 | 143.4 | − 0.4 | 1 | A | ------ | ------ | |
| 27 | Jan. 24 | 142.9 | 143.2 | − 0.3 | 0 | A | ------ | a | |
| 28 | Jan. 25 | 144.1 | 143.0 | + 1.1 | 0 | A | ------ | ------ | |
| 29 | Jan. 26 | 143.9 | 142.9 | + 1.0 | 0 | A | ------ | a | |
| 30 | Jan. 27 | 147.1 | 142.5 | + 4.6 | 0 | B | ------ | ------ | Colton phenomena marked. |
| 31 | Jan. 28 | 165.2 | 142.2 | +23.0 | 0 | B | a | a | |
| 32 | Jan. 29 | 163.0 | 142.1 | +20.9 | 0 | B | ------ | ------ | Colton phenomena weak. |
| 33 | Jan. 30 | 145.1 | 141.8 | + 3.3 | 0 | B | ------ | ------ | Do. |
| 34 | Jan. 31 | 156.6 | 141.5 | +15.1 | 0 | B | a | a | Colton phenomena moderate. |
| 35 | Feb. 1 | 149.5 | 141.3 | + 8.2 | 0 | B | ------ | ------ | |
| 36 | Feb. 2 | 145.4 | 141.1 | + 4.3 | 0 | B | b | ------ | |
| 37 | Apr. 2 | 134.4 | 134.4 | 0.0 | 0 | A | a | a | San Fernando Point Lighthouse. |
| 38 | Apr. 3 | ---------- | ---------- | ---------- | 0 | A | a | a | San Fernando. Colton phenomena weak. |

TABLE 1—Continued.

| No. | Date. | Duration. | | | Mirage. | Type. | Contacts. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Observed. | Computed. | Difference. | | | 1 | 2 | |
| | 1920 | *Seconds.* | *Seconds.* | *Seconds.* | | | | | |
| 39 | Apr. 4 | 134.5 | 134.8 | − 0.3 | ? | A | | a | Colton phenomena marked. |
| 40 | Apr. 5 | 134.5 | 134.5 | 0.0 | 0 | A | a | a | San Fernando. Colton phenomena weak. |
| 41 | Apr. 6 | 134.9 | 134.6 | + 0.3 | 0 | A | b | b | Colton phenomena? |
| 42 | Apr. 24 | 158.8 | 136.9 | +21.9 | ? | ? | b1? | a | Mount Mirador. Colton phenomena very strong. End a thin blue line. |

No. 1 was made with a stopwatch whose rate was unknown; Nos. 2 to 17 were made with the seconds hand of an ordinary watch, whose error was constantly checked by the time ball of the Manila Observatory, and with either a field glass, a galvanometer telescope, or the naked eye, with suitable protection.

When a field glass (a Lemaire 4-power, Galilean) was used with an ordinary watch (Nos. 10 to 17) the left-hand eyepiece was removed and the watch held in front of the left-hand objective, at such a distance that to the left eye the dial, to the right eye the horizon, were both clearly visible. It is difficult to attend to both images at once, but with practice an accuracy of better than a second can be attained.

Nos. 18 to 36 were made with a $\frac{1}{5}$ second stopwatch (works marked Leonidas W. Fy., Switzerland), and a galvanometer telescope with smoked plane spectacle glass covering the objective. This helped greatly in observing lower (first) contact, during the cool months when the sun is very brilliant even near the horizon, but tended slightly to obscure upper (second) contact and so to shorten the observed duration of sunset.

The correction of the stopwatch was found by averaging five runs of 1 hour each, 30 minutes each, 10 minutes each, and 1 minute each (twenty runs in all), and was found to be exactly proportional to the length of the run within limits of starting and stopping errors, and equal to +0.2 sec./min. In all tests and observations initial error (flyback) was allowed for.

Feeling that Nos. 1 to 36 had established the existence of differences between computed and carefully observed durations of sunset, and as I believed that the explanation must lie in peculiarities of atmospheric refraction, the month of April, 1920, was spent in observing low-sun phenomena at San Fernando Point Lighthouse, La Union, and at Baguio. For sunset observing, with the hope of making approximate determinations of atmospheric refraction at both lower and upper contacts and at stations from sea level to an elevation of more than 2 kilometers, the apparatus taken consisted of a watch with a high-grade Elgin movement, a $\frac{1}{5}$ second stopwatch (works marked Mont Brillant W. Fy. Switzerland), a 10-power galvanometer telescope with a light camera tripod, aneroid barometer, thermometer, sling psychrometer, etc. The stopwatch had been carefully rated, as had been done with the other one mentioned above; its rate correction was —1.1 sec./min., its flyback correction +0.1 second, both constant. This watch was used for Nos. 37 and 42; it balked in the middle of No. 38, and the other sunsets at San Fernando Point Lighthouse, Nos. 39 to 41, were timed with a National Park stopwatch, which the keeper in charge, Mr. Fernando Quintos, kindly allowed me to use. Its correction was found to be +0.06 sec./min., constant. I had hoped to use an engineer's Y-level for this work, with a chronometer, but the nonarrival of the chronometer made the Y-level superfluously accurate.

No. 37 was observed with stopwatch and field glass; Nos. 39 to 42 with 10-power galvanometer telescope on tripod, stopwatch, and watch, thus; at lower contact the stopwatch was started, then stopped at an instant known by the watch, started at another known instant, and stopped at upper contact. Thus not only the duration but also the standard time of each contact was determined.

The sun sets at Manila in a water horizon between Corregidor Island and the promontory of Bataan Province, for a few weeks before and after the winter solstice; at other times of the year the sunset is over a land horizon. Before the solstice in 1918 I made no duration observations, not having any idea that they could be of interest; before the solstice of 1919 continued cloudiness made observations at Manila impossible up to December 9, 1919. I was absent from the city during the Christmas recess, when I had hoped to make observations on the duration of sunrise from points on the Pacific shores of Luzon, but again cloudiness prevented.

Nos. 1 to 12 were made on the sea wall along the Cavite Boulevard, Manila, at a point in latitude north 14° 34.4′, longitude east 8 h. 3 m. 55.2 s., by the City Map of the Bureau of Commerce and Industry; Nos. 18 to 36 were made on the sea wall a little farther south, latitude north 14° 34.3′, longitude east 8 h.

3 m. 55.4 s. Depending on the state of the sea, the eye was 3 to 6 feet above actual sea level. For these locations the extremes for duration of sunset, computed from Nautical Almanac data, are approximately

| | Seconds. |
|---|---|
| Autumnal equinox | 132.0 |
| Winter solstice | 147.6 |
| Vernal equinox | 133.1 |
| Summer solstice | 143.0 |

Nos. 13 to 16 and 42, were made at the Meteorological Observatory, Mount Mirador, Baguio, Benguet, latitude north 16° 25′, longitude east 120° 36′; the elevation of the standard barometer cistern is 1512.5 meters, and this is nearly the height of the eye in observing. At this point, during a large part of the year the sun sets in a sea horizon of the China Sea, beyond the Lingayen Gulf and the land about Cape Bolinao.

No. 17 was made at a point on the beach of San Fernando Harbor, La Union, 270 paces northward of the old pier at the end of Calle Coronel Duvall. Measurements on a Coast Survey chart locate this point in latitude north 16° 37.3′, longitude east 120° 18.5′; height of eye about 5.5 feet. From this point the line of sight at sunset passed over the surf of the south coral reef at the harbor entrance and just cleared San Fernando Point.

Nos. 37 to 41 were made at San Fernando Point Lighthouse, La Union, latitude north 16° 37′ 02″, longitude east 120° 16′ 33″; No. 37, from the lighthouse balcony, with the eye at about the level of the lamp, 107 feet; the others, on the ground at the base of the tower, with the eye about 84 feet above the level of the sea. The state of the tide was not considered in computing. The horizon is a sea horizon from north to west southwest, where the islands and land of Cape Bolinao are dimly seen.

In the table, the sixth column, headed "Mirage," indicates whether in any direction there was visible the lifting or floating of land on the horizon, called "looming" by some Cape Cod fishermen. At Manila the sandspit of Cavite, Corregidor Island, and the land near Mariveles, in Bataan Province, served as tests; at San Fernando, the coast north and south, but particularly Santiago Island beyond the Lingayen Gulf. 0 means definitely no mirage observable; 1 and 2, definite or very strongly marked mirage; ? means mirage possible but not certain; leaders indicate here, as elsewhere in the table, no record.

Column 7 indicates the type of sunset, A or B, on which see a later paragraph.

Columns 8 and 9 give data about the contact of 1, lower, and 2, upper limb with the horizon; l, indicates a suspicion that the instant recorded was actually a little tardy; a, perfect contact without blurring; b, less perfect but quite definite.

In the column "Remarks," "Colton phenomena," refers to those peculiar deformations of the sun's limb and face which were first accurately recorded by A. L. Colton,[1] whose sunset photographs made in 1893 still adorn the corridors on Mount Hamilton. These deformations are always present as little ripples on the edge, and may be exaggerated into steps, or notches, or incised gashes, or projecting horns, or the disk may even be split or doubled. They are frequently notable at sea level; at Mount Mirador they are sometimes quite wonderful. They deserve photographic record and careful study, as they afford an optical analysis of the atmosphere from sea level to a great height.

In the course of these observations I have distinguished two types of marine sunset, A and B.

Type A occurs always when mirage is perceptible, and sometimes when it is not, and its observed duration was very nearly equal to the computed, and more nearly as practice and experience gave skill in observation; the agreement is best in those cases where an unshaded telescope and a stopwatch were used, as in Nos. 39 to 41. As the descending sun, vertically compressed by astronomical refraction, approaches the sea horizon, a protuberance of more or less flatness grows out below, and almost simultaneously a line of light appears in the sea horizon, which lengthens horizontally and thickens upward till the protuberance and the line join; the moment of this junction I have called lower contact, 1. For about half the duration of sunset the sun presents the appearance of an inverted fish globe, whose mouth rapidly widens to the sun's diameter; from then on the vanishing disk looks like an ellipse much flattened below, and vanishes as a small elliptical spot, at upper contact, 2. This spot does not sink below the horizon; it "goes out."

Type B never occurs simultaneously with a perceptible mirage, and its observed duration was always greater than the computed, by even as much as 20 or 25 seconds. The descending sun flattens below as it approaches the horizon, which is not always easy to see under it, being comparatively dark. The corners of the disk as it passes below the horizon are rounded, instead of projecting

[1] Colton, A. L., Sunsets at Mt. Hamilton—some curious effects of refraction, Contributions from the Lick Observatory, No. 5 (1895).

like the rim of a fish globe, until about midsunset; then the remaining half-disk begins to show a rim, so that it looks for a time not unlike the "tin hat" or trench helmet of the American Expeditionary Force. This flattens down in the middle faster than it shortens horizontally, becomes a line of light, and disappears in dots and dashes among the waves, if the horizon is near. The disappearance is slow, not like the vanishing of the spot at end as in type A.

I have no definite evidence to explain these two types, my attempts to determine refraction not having been successful in enough cases to warrant a conclusion. But as type A is always associated with horizon mirage, if that is observable, it is doubtless due to the same cause, a reversal of the normal gradient of the atmospheric refractive index in the lower layers of the atmosphere. This would explain its peculiarities.

By analogy, type B would be due to an intensification of the normal gradient, in the lower layers of the air. If this were great enough, it would cause light to follow the curve of the ocean surface, so that objects would be visible at distances indefinitely great, or until the light had all gone by absorption. That considerable intensification of the normal gradient occurs is the reason why islands are sometimes visible at unusual distances at sea, as observed from the steamer "Venezuela" in June, 1918, when islands were plainly seen to the north while the ship was in a position between Shimonoseki and Quelpart Islands, and nearing the latter. One of the navigating officers told me that from that or any neighboring position he had never before seen these islands in several voyages. Objects on the shore of Martha's Vineyard are sometimes visible over the curve of the horizon from Woods Hole which usually are entirely invisible; this is generally most marked under the clouds of a retreating northeaster. Such a strengthened gradient would cause a strong flattening of the sun's lower limb, so great that it might become difficult to judge the true moment of contact, and one would probably estimate it in advance of the truth. There would also be a flattening of the upper limb as it approached the ocean surface, producing a "tin-hat" form, and a final vanishing line of light. The observed excessive durations I would, therefore, attribute to hasty judgment of the moment of lower contact; though with the utmost caution I have been unable to shorten these durations. They are certainly not due to carelessness or to inexperience in the use of a stopwatch.

If these hypotheses are true, type A should always be accompanied by abnormally small refractions; type B, by abnormally large.

But No. 42 is explainable by neither hypothesis. It was observed from high level, 1512 meters, the disk was considerably distorted in its descent, there was no material flattening of the disk at lower contact or before, yet the end was a thin blue line. On account of the difficulty of judging the moment of lower contact with a somewhat hazy sea horizon 75 miles away I supposed, till I had computed the duration from the records, that lower contact had been noted too late. Yet the duration came out longer by 21.9 seconds than that computed. The distortion was such as to prevent an assignment to either type.

Diffraction at upper contact has also suggested itself as a plausible cause for a real, not merely an illusory, prolongation of sunset. It could never show itself with a mirage, but a normal or an intensified normal gradient would be favorable. It would cause an apparent increase of refraction at upper contact as compared with lower.

# MALAYAN BEES

By T. D. A. Cockerell

*Of the University of Colorado*

The bees described or recorded in this paper were all received from Prof. C. F. Baker, to whom we are indebted for greatly increasing our knowledge of the species of Borneo, Singapore, and Penang. As he remarked, these materials are of much interest to any student of the Philippine fauna, because it is not until we know what is found in other Malay regions that we can determine the percentage of really endemic Philippine species or form any distinct idea of the lines of migration which originally populated that area. In other words, the biota of the Malay Archipelago and Peninsula must be studied essentially as a whole, though this is necessarily a vast undertaking, which cannot be completed within the lifetime of present-day workers.

## Genus NOMIA Latreille

Males, with hind femora greatly enlarged or subglobose.. **pachypoda** sp. nov.
Females, or if males, hind femora not greatly enlarged .......... 1.

1. Abdomen with green or green and red tegumentary bands; postscutellum unarmed .......... 2.
   Abdomen without such bands .......... 7.
2. Abdomen with only three bands (none on first segment); first two segments metallic; female .......... **subpurpurea** sp. nov.
   Abdomen with at least four bands (in one Penang male *N. strigata*, the band on first segment has not acquired the green color) .......... 3.
3. Legs at least partly red .......... **tuberculifrons** Cockerell.
   Legs black .......... 4.
4. Bands mainly red, with some yellowish green ...... **selangorensis** sp. nov.
   Bands without red .......... 5.
5. Males (Penang, *9610*) .......... **strigata** (Fabricius).
   Females; clypeus keeled .......... 6.
6. Abdominal bands with strong lilac tints (Singapore, *9604*). **strigata** (Fabr.) variety.
   Abdominal bands without lilac tints (Singapore, *9606*; Penang, *9605*). **strigata** (Fabricius).
7. Abdomen with white or cream-colored tegumentary bands .......... 8.
   Abdomen without such bands .......... 9.
8. Base of abdomen largely pale red; scutellum dull. **leucozonata penangensis** subsp. nov.
   Base of abdomen black; scutellum shining .......... **perconcinna** Cockerell.

9. Abdomen clavate; males.......... 10.
   Abdomen not clavate .......... 11.
10. Abdomen red at base.......... mediorufa morata subsp. nov.
   Abdomen black at base.......... elongata Friese.
11. Abdomen red at base; females.......... mediorufa morata subsp. nov.
   Abdomen black at base.......... 12.
12. Scutellum with fulvous tomentum; males.. scutellata remolita subsp. nov.
   Scutellum without fulvous tomentum.......... 13.
13. Larger; wings strongly infuscated apically.......... incensa sp. nov.
   Smaller; wings little darkened apically (Puerto Princesa, Palawan). palavanica Cockerell.

**Nomia pachypoda** sp. nov.

*Male.*—Length, about 7 millimeters; robust, black with broad abdomen; eyes strongly converging below; tongue long and slender; maxillary palpi with basal joints dark, apical ones pale fulvous; mandibles pale, somewhat reddish; labrum black; face densely covered with ocherous hair; front dull; scape with long outstanding hair; flagellum bright ferruginous beneath; mesothorax, scutellum, and postscutellum densely covered with felt-like fulvous hair; postscutellum unarmed; pleura and metathorax with long ocherous hair; basal area of metathorax very small, minutely granular; tegulæ fulvous, rather large but ordinary; wings dusky, stigma (which is small and short) and nervures pale dusky reddish; basal nervure strongly arched; second submarginal cell narrow, receiving the first recurrent nervure beyond the middle; legs mainly black, with pale ocherous hair, but anterior and middle knees, and anterior tibiæ at apex, ferruginous; all the tarsi pale yellow, slightly reddish, with the last joint black, abruptly contrasting; hind femora enormously swollen, helmet-shaped, the basal slope above shining, the apex broadly reddish creamy; hind tibiæ pallid at base, and gibbous on outer side near base, with a pair of small black tubercles; abdomen finely rugose-punctate; first segment with erect ocherous hair; second and following segments with ocherous hair bands; sixth and seventh appearing entirely pallid; fourth ventral segment broadly emarginate, keeled in the middle.

Singapore (*Baker 9982*), type; also one from Penang (*Baker 9981*).

**Nomia subpurpurea** sp. nov.

*Female.*—General appearance and color of abdominal bands (emerald green tinged with vermilion) as in *N. iridescens rhodochlora* Ckll.; first and second abdominal segments metallic as in typical *iridescens*. The face is longer in proportion to its breadth than in true *iridescens*. It is readily known from both *iridescens* proper and *rhodochlora* by the larger, flattened scutellum, which is entirely dull, with a granular surface. Tegulæ fulvous, black in front and narrowly at base. Wings dusky.

Singapore (*Baker*).

**Nomia tuberculifrons** Cockerell.

Both sexes from Singapore (*Baker*). The male is new; it differs by being less robust; the scape entirely red in front; third and fourth antennal joints conspicuously red; lower half of clypeus ferruginous, shining, with very few punctures, upper half keeled, labrum and mandibles red; hind legs slender and simple, except that the tibiæ are broadened apically, and the apical portion is bent or twisted out of a line with the rest. The abdomen has five pale green bands, slightly tinged with red. The nervures are pale fuscous, not black as described for *N. erythropoda*, but in general the description of *erythropoda* agrees well, and it is possible that *tuberculifrons* is *erythropoda*, or a race of it.

**Nomia selangorensis** sp. nov.

*Female.*—Length, about 9 millimeters; robust, black, first four abdominal segments with tegumentary bands, which are pale vermilion, with some green, mainly on first segment; hair of cheeks white, of vertex sooty, of face whitish; mandibles black; clypeus strongly keeled, shining on each side of the keel; front dull and minutely granular; flagellum bright ferruginous beneath; mesothorax and scutellum dull and minutely granular; area of metathorax a transverse sulcus crossed by delicate raised lines; hair of mesothorax and scutellum scanty and black, of postscutellum dense and pale ocherous; tubercles fringed with pale ocherous hair; tegulæ fulvous, dark in front; wings dusky, stigma and nervures dusky reddish; first recurrent nervure joining the rather broad second submarginal cell not far from end; legs black, with pale hair, tarsi chestnut red apically; hind basitarsi broad, and with fulvous hair on inner side; abdomen polished and shining, with very minute scattered punctures; first segment at sides with erect brownish ocherous hair; the second and third segments have very scanty short dark hair, appearing bare at first sight.

Malay Peninsula, Selangor (*Baker 9612*). From such species as *N. strigata* this is known by the polished abdomen.

**Nomia leucozonata penangensis** subsp. nov.

*Female.*—Length, about or nearly 9 millimeters; agreeing in general with the description of *N. leucozonata* Cameron, from

Borneo, but apparently larger, and certainly with less red on abdomen. Cameron's diagnosis is not consistent in all respects with his detailed description. In our insect the first abdominal segment is pale fulvous, with a broad transverse black band, pointed at each end, and not reaching the lateral margins; in the middle, this band is more distant than the equivalence of its width from the hind margin. The second segment is black, with the base pale fulvous, more broadly at sides. The other dorsal segments are black, and 2 to 4 have marginal tegumentary ivory-colored bands. On the ventral side the first two segments are red or fulvous suffused with dusky, and the third fulvous with a transverse black band. Other characters are: Clypeus shining, depressed in middle, its apical margin red; mandibles red subapically; face and front, all except lower part of clypeus, densely covered with very pale ocherous hair, hiding the surface; cheeks with white hair; scape red basally; flagellum red beneath; mesothorax and scutellum dull and appearing bare, with thin, short, pale hair, a few long dark hairs on scutellum; postscutellum densely covered with ocherous-tinted tomentum; base of metathorax with a curved transverse channel, crossed by irregular small plicæ laterally; tegulæ fulvous; wings strongly dusky, with a large subapical cloud; stigma piceous, rather large; nervures fuscous; anterior tibiæ clear fulvous in front, middle tibiæ with fulvous band in front; hind basitarsi broad. The tongue is very long and slender.

Penang (*Baker 9609*).

**Nomia perconcinna** Cockerell.

Penang (*Baker*). Possibly a distinct race of this Indian species, as it differs from the type by the hind tibiæ being entirely black and the flagellum duskier red beneath. It is allied to *N. albofasciata* Smith, but differs conspicuously in the color of the pubescence.

**Nomia elongata** Friese.

Penang (*Baker 9611*). This is the real *N. elongata*, agreeing with Friese's description of the ventral surface of abdomen. Except for the ocherous hair of face and abdominal bands, this agrees with Smith's description of *N. clavata*, from Gilolo; but that description could be applied to several species of this type.

**Nomia mediorufa morata** subsp. nov.

*Female.*—Length, about 7 millimeters. Differs from typical *N. mediorufa* Ckll., from Formosa, as follows: Flagellum black above except apically; band on second abdominal segment interrupted in middle; first and second abdominal segments red apically, or first all red except lateral subapical dark patches.

*Male.*—Slender, with clavate abdomen, the first segment entirely red, the second broadly red in middle apically; face densely covered with tawny hair; antennæ very long, flagellum entirely ferruginous beneath; all the tarsi cream-colored more or less tinged with reddish; anterior tibiæ pale ferruginous, as also the other tibiæ at base and apex, and the middle ones largely in front; hind legs slender and simple; wings dusky, with a diffuse apical cloud; stigma and nervures pale brown; stigma large; second submarginal cell receiving first recurrent nervure in middle; second abdominal segment finely but distinctly punctured, and depressed or constricted basally.

Singapore (*Baker*). The type is a female (*9983*) with broad black band on first abdominal segment. The male is *Baker 9607*.

**Nomia scutellata remolita** subsp. nov.

*Male.*—Differs from typical *N. scutellata* Smith by the wings not being clear hyaline. It is very close to *N. ustula* Ckll., but hind trochanters of male are not toothed, the apical lobe of hind tibiæ is dark, the stigma yellowish ferruginous, and the area of metathorax distinctly sculptured, with cross striæ in middle and fine plicæ at sides. It is also near to *N. takauensis* Friese, from Formosa, but differs in the color of the abdominal bands, which are yellowish brown in *takauensis*. It is also very near to *N. philippinensis* (Friese). All these insects form a little group, with representative races or species in different regions, from India and Ceylon to Formosa and the Philippines. In *remolita* the abdominal hair bands are dull white, and the wings are dusky brownish, with a relatively small ferruginous stigma.

Singapore (*Baker 9608*). *Nomia scutellata* was described from the female. Meade-Waldo ascertained that *N. albofimbriata* Cam. was identical, and believed that *N. ustula* Ckll., from Ceylon, was the male.

**Nomia incensa** sp. nov.

*Female.*—Near to *N. levicauda* Ckll., but somewhat larger (anterior wing, 7 millimeters long); wings strongly dusky apically; mesothorax conspicuously larger; middle of front entirely dull; second abdominal segment very finely and closely punctured all over, the following segments dull, not polished and shining. The abdomen has a thin ventral scopa of long hairs. The second submarginal cell is large and square, receiving the first recurrent nervure considerably beyond the middle. The hind margins of the abdominal segments are rufous, and have broad ocherous hair bands, broadly interrupted on first segment, more narrowly on second. Venter of abdomen partly fulvous.

Luzon, Montalban (*Baker*).

**Halictus semirussatus** sp. nov.

*Male.*—Length, about 8 millimeters; anterior wing, a little over 6; head and thorax black, the mesothorax slightly blue-black; abdomen bright chestnut red, with a basal and two lateral blackish stains on first segment; legs black, with anterior and middle knees, and anterior tibiæ in front (except apex) ferruginous, tarsi more or less reddish apically, hind basitarsi pallid at base. Eyes large, subemarginate within (inner orbits strongly concave); cheeks and sides of face with white hair; clypeus prominent, apically with a very broad (broadest in middle) creamy-white band, which is strongly and sparsely punctured; labrum cream color; mandibles ferruginous; antennæ long, black, the flagellum obscurely brown beneath, not moniliform; front dull, shining at sides; thorax with dull white hair, dense on postscutellum; tubercles prominent and angular, red at apex; mesothorax and scutellum very densely punctured, somewhat glistening; scutellum distinctly bigibbous; area of metathorax very large, strongly defined, shining, with very strongly longitudinal ridges, which are slightly divergent; sides of metathorax very hairy, posterior face sharply defined all round; tegulæ castaneous; wings hyaline, dusky at apex; nervures and stigma reddish brown; second submarginal cell square, receiving first recurrent nervure near the end; third submarginal cell unusually short; outer nervures distinct; legs with pale hair, pale golden on inner side of tarsi; abdomen shining, first segment hardly punctured, second duller, with very minute punctures; rather thin pale hair bands at bases of second and following segments; fourth ventral segment with large tufts of yellowish white hair.

Singapore (*Baker 9984*). A very distinct species, perhaps rather approaching *H. cattulus* Vachal (not *catullus*, as Bingham has it), but known by the red abdomen. *Halictus himalayensis* Bingh. has the greater part of the abdomen blood-red, and seems to be somewhat related.

**Anthophora caldwelli** Cockerell.

Malay Peninsula, Selangor (*Baker*), one male. Described from Foochow, China. The specimen is smaller than Chinese males, but the difference is probably not racial.

**Coelioxys siamensis** Cockerell.

Malay Peninsula, Selangor (*Baker*). Described from Trong, Siam.

**Prosopis feai** Vachal.

Penang (*Baker*). One female, having the scutellum immaculate, and the apical yellow mark on clypeus obtusely triangular. As at present understood, *P. feai* is quite variable, and with more material it may be possible to distinguish more than one species. Bingham erroneously describes the clypeus of the female as yellow; Vachal indicates that there is only a yellow spot. Bingham's figure also shows the spot.

**Prosopis penangensis** sp. nov.

*Female.*—Like the Philippine Islands *P. opacissima* Ckll., but easily known by the polished, shining scutellum, with some very large punctures along the sides. The first abdominal segment is polished and shining, with excessively minute punctures. The yellow clypeal mark is large and oblong, and the lateral marks are broad-cuneiform. The middle and hind basitarsi are yellow but the anterior ones are brown. This is a much smaller species than *P. feai*, with entirely opaque mesothorax. In the Indian fauna it seems nearest to *P. scutula* Vachal, but the nervures are not pale testaceous yellow, and the tegulæ are brown with a large yellow spot anteriorly. The yellow band on prothorax is interrupted. The eyes are brown.

Penang (*Baker 9986*).

**Nomada dissessa** sp. nov.

*Female.*—Length, about 6 millimeters; ferruginous red, the head and thorax dusky, but the clypeus, supraclypeal area, tubercles and scutellum paler; no yellow anywhere about the insect; face broad; mandibles and labrum simple; antennæ long, scape red, flagellum black with a very obscure reddish tint beneath; third antennal joint long, fourth shorter; mesothorax bare, coarsely punctured, shining beneath the punctures; scutellum bigibbous; pleura and metathorax with conspicuous white hair; tegulæ bright ferruginous; wings hyaline, faintly dusky, more so at apex; nervures and stigma dark rufo-fuscous; only two submarginal cells, basal nervure going basad of transverse median; second recurrent nervure joining second (morphologically second + third) submarginal cell a considerable distance from its end; legs red, hind tarsi darker; abdomen shining red, hind margins of first four segments broadly and conspicuously dusky; first segment with two large triangular dark areas; segments 2 to 4 each with lateral patches of glittering white hair, only seen in a side view of the abdomen.

Luzon, Mount Maquiling (*Baker*). In my table of Philippine *Nomada* this runs straight to *N. palavanica*, a smaller species without dusky bands on abdomen. It really most resembles *N. lusca* Smith, but is not a variation of that with only two submarginal cells, as the mesothorax is more coarsely sculptured, the area of metathorax is more polished posteriorly, and the first recurrent nervure joins the second submarginal cell very much nearer its base.

**Nomada polyodonta** sp. nov.

*Male.*—Length, about 6.3 millimeters; head and thorax black, with the following parts ferruginous: Lower margin of clypeus broadly, lower corners of face, labrum, mandibles, upper border of prothorax, tubercles, anterior corners of mesothorax, greater part of pleura (but not bright, and lower part black), scutellum, and postscutellum; front and mesothorax very densely and coarsely punctured; head large, with broad face, which is covered with glittering white hair; scape black, with a bright red spot at base in front, more or less extended as a line upward; flagellum black, chestnut red beneath, the joints conspicuously denticulate; second antennal joint concealed, third about equal with fourth; thorax bare above, pleura and metathorax with rather thin white hair; tegulæ bright fulvo-ferruginous; wings strongly dusky at apex; stigma and nervures piceous; basal nervure going basad of transverse median; three submarginal cells, second receiving first recurrent nervure a little before its middle; legs mainly black, knees red, anterior and middle femora and tibiæ red in front (middle femora obscurely), anterior tarsi red; hind tibiæ red at apex; abdomen petiolate, narrowed basally, mainly black; first segment reddened on hind margins except in middle; second with a pair of very large subquadrate red patches, widely separated (not closely approaching as in *N. adusta*); fourth segment with a red band, interrupted mesally and laterally; apex light reddish.

Penang (*Baker*). Very like the Indian *N. adusta* Smith, which I have from the Khasia Hills (*Sladen*), but easily known by the denticulate antennæ.

**Allodape sauteriella** Cockerell, variety *a*.

*Female.*—Length, about 5 millimeters, distinctly smaller and less robust than typical *A. sauteriella,* from Formosa, but with no other tangible differences. Scape black; basitarsi dark; mesothorax shining; scutellum dull. The face mark has been turned bright red by cyanide; it may have been yellower than *sauteriella.*

Penang (*Baker 9976*). This may be separable when the male is known.

**Allodape breviceps** sp. nov.

*Female.*—Length, about 5.5 millimeters; similar to *A. sauteriella* var. *a,* but readily distinguishable as follows: Head considerably shorter, the eyes therefore shorter and appearing more bulging; face mark broader, its diameter where constricted in middle greater than a side above the constriction; scape cream-color in front; tarsi entirely cream-color; first recurrent nervure joining second submarginal cell much more distant from base; basal half of abdomen obscure brown. The constriction of the very broad face mark is about the middle, not conspicuously below it as in *A. hewittii sandacanensis* Ckll.

Penang (*Baker*).

## Genus CERATINA Latreille

The following key separates a series of specimens before me:

Scutellum entirely black (Penang Island, *Baker*) ........ **dentipes** Friese.
Scutellum at least mainly yellow ........ 1.
1. Postscutellum at least mainly yellow ........ 2.
Postscutellum entirely black ........ 3.
2. Face below antennæ nearly all yellow; small (Penang) .... **metaria** sp. nov.
Face below antennæ with two large leg-shaped black marks (Penang). **bipes** sp. nov.

3. Clypeal yellow band without any distinct median upper lobe (Baguio, Benguet) .......... bicuneata Cockerell.
   Clypeal yellow band with a well-developed median upper lobe.......... 4.
4. Mesothorax all black (Penang Island, *Baker 9974*). conscripta Cockerell.
   Mesothorax with four yellow lines or stripes.......... 5.
5. Larger; sixth abdominal segment with a large subquadrate yellow patch, emarginate on each side (Singapore).......... incerta Cockerell.
   Smaller; sixth abdominal segment with a yellow band, broadly emarginate in middle above (Penang, *Baker 9975*).... accusator Cockerell.

**Ceratina metaria sp. nov.**

*Male.*—Length, 4 millimeters or slightly over; rather pale dull yellow, with black markings as follows: H-like mark on face, the crossbar between clypeus and supraclypeal yellow patch; front, vertex, and occiput all black except linear extension of lateral face marks (which are squarely truncate above) a short distance up orbits, and a small mark near top of eye; upper part of cheeks, and posterior portion behind the broad yellow band, black; mesothorax black with four well-defined yellow stripes, which do not reach front or hind margins, though the lateral ones almost touch hind margin; axillæ partly black; area of metathorax and posterior face black; abdomen dark brown at base, and with five black bands, about as broad as the intervals between them, fifth band with a more or less distinct linear interruption. The legs and pleura are entirely yellow. Scape yellow in front; flagellum dark reddish brown beneath; mesothorax highly polished, without evident punctures, its posterior margin dull; tegulæ testaceous; wings hyaline, faintly dusky, stigma and nervures brown; apex of abdomen broadly rounded, without a projecting point.

Penang (*Baker*). Resembles *C. beata* Cam., but smaller, with more yellow on sides of thorax, etc.

**Ceratina bipes sp. nov.**

*Female.*—Length, about 7 millimeters; black and yellow. Head black, with yellow marks as follows: Broad band on cheeks, extending to occiput; base of mandible (which is very broad); labrum; reversed T on clypeus, the upper part broad and bulbous; supraclypeal band; two elongate-oval spots in front of ocelli; and lateral face marks extending to vertex, narrowed to a line above, but ending in a round spot. The black areas left on face resemble the front legs of a short-legged dog. Scape slender, with a yellow stripe in front; flagellum very faintly brownish beneath, mesothorax black with four yellow stripes, the lateral ones very broad, and marginal; broad anterior margin of mesothorax dull and finely punctured, the rest polished and impunctate; scutellum, postscutellum, and axillar spot yellow; metathorax yellow with the basal area black; upper part of prothorax, tubercles, and large irregular area on pleura yellow, the latter with a posterior extension; tegulæ testaceous; wings dusky, especially in region of marginal cell and beyond; stigma and nervures dark brown; anterior legs yellow, the tibiæ dusky beneath, and the coxæ with a broad black band anteriorly; middle femora with apex above and a stripe beneath, and their tibiæ on outer side, yellow; hind legs black, with the coxæ largely pale; first abdominal segment yellow, with large black lateral marks, connected by an irregular band across the middle; the other segments are black and rugose, the hind margins of 2 to 4 with narrow yellowish bands, of 5 with a broad band, emarginate in middle anteriorly; venter with first three segments mainly pale, the others dark.

Penang (*Baker*). Resembles *C. ridleyi* Ckll. and *C. canarensis* Ckll., but smaller, and differing in the markings.

# NOTES ON TREMATODES FROM THE PHILIPPINES [1]

By Ernest Carroll Faust

*Parasitologist, Union Medical College, Peking, China*

ONE PLATE

Through the courtesy of Prof. Frank G. Haughwout I have had an opportunity to examine three flukes from the Philippines which are described in this paper.

**Fasciola gigantica** Cobbold 1856. Plate 1, figs. 1 and 2.

*Fasciola gigantica* is a long lanceolate fluke found in the liver of a carabao, *Bubalus bubalus* Linn., killed at Manila. It has a length measurement of 29 to 36 millimeters and a width of about 8 millimeters. Although the sides of the body are almost parallel there is a distinct anterior end in the form of a cone, a characteristic which shows its relationship to *Fasciola hepatica*. The integument is uniformly spinous. In the region of the uterus the body is distended dorsoventrad, but along the margins it is compressed and slightly fluted.

The oral sucker is small (13 millimeters) while the acetabulum, almost within the limits of the anterior cone, is 22 millimeters in diameter. A very small pharynx leads into a typical fascioliform digestive tract. Compared with *F. hepatica* the secondary cæcal branches number almost twice as many and the ultimate pockets are much more numerous. The general type of branching is, however, quite the same in the two species.

The excretory bladder extends anteriad as far as the oötype.

The organs of the genital system offer a ready method of differentiating this species from *Fasciola hepatica*. The testes are confined to the anterior half of the animal. The posterior testis is fairly compact and has five or six main arms. The anterior testis, which lies just in front of its mate, is more elongated and has about eight arms. The ultimate testicular cæca are definitely set off from the tubes which lead out into the vasa efferentia, so that the entire organ has the appearance of berries

[1] Contribution from the department of pathology, Union Medical College, Peking.

united into a compound panicle. Long slender vasa efferentia convey the sperm to the region immediately anterior to the acetabulum, where they unite to form a single vas deferens. Where the short vas deferens enters the cirrus sac it bends to the left and enlarges to form the seminal vesicle. This organ twists on itself and then turns anteriad to form the penis. The latter is quite muscular and has the shape of a bottle with a long neck. The genital pore lies just behind the pharynx in the median line.

The ovary is composed of numerous branches lying to the left of the oötype. It is relatively small. The vitellaria extend from the region of the acetabulum to the subdistal margin of the worm. The ventral follicles are strictly lateral, but the dorsal portion of the glands extends mesad in the posterior half of the worm. The vitelline ducts are less readily made out than in *Fasciola hepatica*. The transverse duct lies just behind the oötype. At its middle a short duct runs into the latter organ. The uterus coils on itself several times, then crosses over to the acetabulum and reaches the genital pore on the left of the cirrus sac.

The eggs measure 140 to 160 $\mu$ by 75 to 90 $\mu$, with an average of 145 $\mu$ by 85 $\mu$, as distinguished from the measurements of *Fasciola hepatica* eggs, which have an average of 132 $\mu$ by 70 $\mu$.

## DISCUSSION

The literature on the genus *Fasciola* is considerable, even when one takes into account only the species closely related to *Fasciola hepatica*. With the removal of the species *magna* to a new genus, *Fascioloides* (Ward 1917:3) (4), one is confronted only with the possible species *F. hepatica*, *F. angusta* Railliet, *F. aegyptiaca* Looss, and *F. gigantica*. A close inspection shows that the latter three species are alike in all respects in which they differ from *F. hepatica*. They are elongated flukes with parallel lateral margins. Their anterior cone is distinct but short. Their testes are richly branched but short and occupy a field much more restricted than those of *F. hepatica*. Ovary and vitellaria are richly branched. The lateral divisions of the gut are more numerous. The acetabulum is relatively large and close to the oral sucker. The cirrus pouch is small and much more contracted than in *F. hepatica*. Moreover the egg measurements are remarkably similar, averaging 147 $\mu$ by 82 $\mu$ for *F. angusta*, 150 $\mu$ by 80 $\mu$ for *F. gigantica* of Egypt, and 145 $\mu$ by 85 $\mu$ for the material which I have studied.

In as far as the present data are concerned there is adequate proof that all of the species of *Fasciola sensu stricto* exclusive of *F. hepatica* belong to the same species, *F. gigantica* Cobbold 1856. With this view Blanchard (1895:733) (1) and Stephens (1916:244) (2) are in accord.

*Fasciola gigantica,* which has been regarded as a parasite of man, is found in a great variety of ruminants. The present record supports the view that it is more widely distributed than had been previously believed.

**Paramphistomum anisocotylea** sp. nov. Plate 1, fig. 3.

This new species of amphistome, for which I propose the name *Paramphistomum anisocotylea,* was taken from the same host, *Bubalus bubalus,* from which *Fasciola gigantica* was secured. The fluke is ovoid in shape, measuring 6 to 6.3 millimeters long by 3.5 to 4 millimeters wide. It has a conspicuous acetabulum with a diameter somewhat greater than half the animal's length (3.1 to 3.4 millimeters). The fluke is uniformly aspinose.

The oral sucker with a diameter of 0.85 millimeter is directed anteroventrad. A short pharynx without pockets lies immediately above the oral sucker and leads into a short œsophagus. The cæca are inflated, sausage-shaped pouches, which extend to the mid-region of the acetabulum.

The testes lie in tandem arrangement between the oötype and the metraterm. They are large, subovoid to rhomboid in contour, with small vasa efferentia leading anteriad toward the genital pore. The ovary is a small oval body situated immediately to the right of the oötype and is connected with the latter by a short oviduct. Vitellaria extend from the region of the oral sucker to the posterior half of the acetabulum. The follicles are large and are spread out in a patelliform pattern. Short vitelline ducts connect these follicles with the oötype. No seminal receptacle has been found, but a Laurer's canal is clearly made out. The oötype is surrounded by a spheroidal mass of shell glands. Leading out of the oötype is a very small uterus, which runs forward to the anterior region of the acetabulum where it enlarges and at the same time begins to coil. After a complicated series of serpentine twists it proceeds to the genital pore.

The matured eggs measure from 140 to 160 $\mu$ in length by 70 to 85 $\mu$ in width with an average of 150 by 80 $\mu$.

*Paramphistomum anisocotylea* differs in size, relation of the genital organs, and in other particulars from the previously described *Paramphistoma,* but is especially differentiated by the extremely large acetabulum. Perhaps it most nearly approaches *Paramphistomum explanatum,* which species is, however, larger and has heavily lobed testes (Fischoeder 1904:599).(3)

**Phagicola pithecophagicola** g. et sp. nov. Plate 1, figs. 4 to 6.

This interesting fluke was secured from the intestine of the monkey-eating eagle, *Pithecophaga jefferyi* Grant. A few of the specimens were obtained in a smear prepared by Professor Haughwout from the host soon after death. Others were teased out of a portion of the intestine which had been fixed in Bouin's fluid and preserved in 80 per cent alcohol. The host was determined by Mr. R. C. McGregor, ornithologist of the Bureau of Science, Manila.

*Phagicola pithecophagicola* is a minute fluke with a pyriform body which is entirely covered with jagged spines. The oral sucker is directed almost entirely forward and has on its inner margin an uninterrupted circlet of twelve blunt spines (Plate 1, fig. 5). The body measures 0.35 millimeter in length by 0.22 millimeter in greatest width. The oral sucker is fairly constant in diameter, averaging 78 $\mu$. The acetabulum, somewhat behind the middle of the body, measures only 47 $\mu$ in diameter. The region of the body between the two suckers is capable of enormous extension as is also the unforked portion of the intestine.

A long prepharynx leads back into the pharynx, an important sphincter 26 $\mu$ in diameter, which lies midway between the oral sucker and the acetabulum. Behind this is a moderately long œsophagus. The cæca extend far laterad, but reach no farther posteriad than the middle of the acetabulum.

The excretory system has a bladder approaching that of the Brachycoeliinæ, intermediate between a typical V-type and a typical Y-type. It possesses little or no muscular elements. The collecting tubules of the worm have not been worked out.

The testes are ovoid glands about 70 $\mu$ in greater diameter, slightly oblique in position, considerably postacetabular and usually lying ventral to the vitelline follicles. The cirrus sac is lacking. The seminal vesicle is a flask-shaped organ lying transversely just behind the acetabulum, curving anteriad on the right side of that organ and proceeding forward as a nonmuscular cirrus tube which coils only slightly as it advances to the genital pore. No prostate glands have been found.

The ovary is situated to the right of the oötype. It is subovoid in outline and appreciably smaller than the testes. The seminal receptacle is a flask-shaped organ lying in a plane slightly anterior to the ovary. Between it and the oötype rising dorsad, is a small Laurer's canal (Plate 1, fig. 6). A short oviduct can be traced into the oötype. Around the oötype are numerous shell glands. The vitellaria consist of from four to six large follicles on each side of the body, confined to the posterior limit. The uterine mass occupies a major portion of the body posterior to the acetabulum. A single coil on the right side of the acetabulum runs toward the genital pore, which is situated just below the forking of the intestine. The eggs average 21 $\mu$ by 11 $\mu$ in diameter.

## DISCUSSION

A close study of *Phagicola pithecophagicola* shows it to belong to a group possessing in part the characters of the Brachycoeliinæ, in part those of the Microphallinæ, in part those that are unique. It differs from the Brachycoeliinæ mainly in the position of the vitellaria, ovary, and testes. It differs from the Microphallinæ mainly in the possession of an uninterrupted circlet of blunt spines inserted on the inner margin of the oral sucker. In view of the differences of these fundamental points, critical in the classification of trematodes, it seems wise to recognize this as the representative of a new genus, *Phagicola,* and create for it a new subfamily, **Phagicolinæ.**

*Designation of subfamily Phagicolinæ.*—Minute distomes with spinose body and an uninterrupted circlet of spines on the inner margin of the oral sucker. Cæca short, not surpassing acetabulum. Excretory bladder intermediate in type between a V- and a Y-form. Vitellaria postacetabular, consisting of a few large follicles. Testes unlobed, slightly oblique, far postacetabular. Ovary, seminal receptacle and seminal vesicle postacetabular. Cirrus sac and prostate glands lacking, cirrus tube nonmuscular. Genital pore antacetabular.

Type and sole genus, *Phagicola.*

Type species, *Phagicola pithecophagicola.*

## REFERENCES

(1) BLANCHARD, R. Traité de pathologie génerale. Bouchard (1895) 733.

(2) FANTHAM, H. B., STEPHENS, J. W. W., and THEOBALD, F. V. The Animal Parasites of Man. John Bale, Sons & Danielsson, Ltd., London (1916) 244.

(3) FISCHOEDER, F. Weitere Mitteilungen über Paramphistomiden der Säugetiere. Centralbl. f. Bakt. Parasit. 1 Abt. Orig. 35 (1904) 598.

(4) WARD, H. B. On the structure and classification of North American parasitic worms. Journ. Parasitol. 4 (1917) 1.

## ILLUSTRATION

### Plate 1

Fig. 1. *Fasciola gigantica* Cobbold; ventral view; showing details of reproductive organs; × 4.4.

2. *Fasciola gigantica;* details of seminal vesicle and cirrus organs; × 17.
3. *Paramphistomum anisocotylea* sp. nov.; ventral view; × 13.
4. *Phagicola pithecophagicola* g. et sp. nov.; ventral view; × 154.
5. *Phagicola pithecophagicola;* detail of oral sucker, showing spines; × 308.
6. *Phagicola pithecophagicola;* detail of region of oötype, showing ovary, Laurer's canal, seminal receptacle, proximal end of uterus and vitelline ducts; highly magnified.

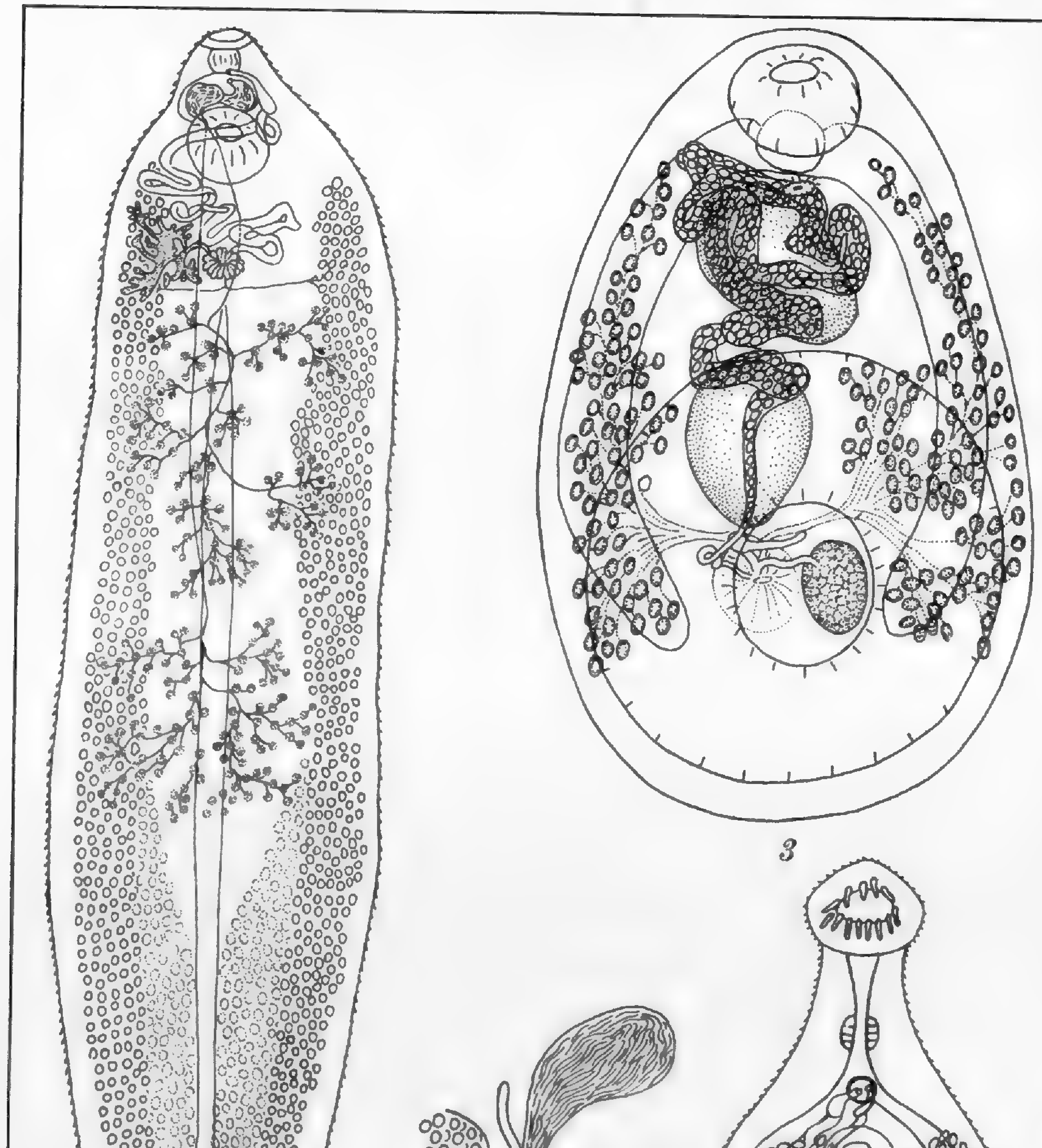


PLATE 1. PHILIPPINE TREMATODES.

# BLACK SPOT OF CITRUS FRUITS CAUSED BY PHOMA CITRICARPA McALPINE

By H. ATHERTON LEE

*Mycologist, Bureau of Science, Manila*

FOUR PLATES

Black spot of citrus fruits was described by McAlpine [1] from Australia, in 1899. McAlpine observed the presence of a fungus uniformly associated with this black spotting and described it as *Phoma citricarpa,* the cause of the disease. No isolations of the fungus or reinoculations are reported in his description. The purpose of the present paper is to present data of such isolation and reinoculation experiments with *Phoma citricarpa* and also to record further knowledge as to the distribution of the disease. In calling attention to the disease and its distribution, it is also hoped that some assistance will be rendered to growers in the citrus-producing countries where it does not yet occur, since with a full knowledge of its characteristics it can be easily excluded. Photographs are presented to facilitate the recognition of the disease.

## DESCRIPTION OF THE DISEASE

The spots are found only on the fruits; the leaves and twigs have not been affected, in the experience of the writer. The disease has been observed upon fruits of the sweet orange (*Citrus sinensis*) and the mandarin orange (*Citrus nobilis*). Pummelos (*Citrus maxima*) and calamondins (*Citrus mitis*), although seen in countries where the disease is common, as yet have not been found to be affected. Lemons are reported by McAlpine to be affected. Data are not yet available as to the other species.

Small, reddish-brown spots appear on the surface of the fruit; with increasing age these spots turn darker, becoming sometimes entirely black. The spot may be only 1 or 2 millimeters in diameter, but with time the area may spread to from 7 to 9 millimeters in diameter. As the spot matures a reddish-brown,

[1] McAlpine, D., Fungus diseases of citrus trees in Australia and their treatment. Government Printer, Melbourne (1899) 21, 22, 81.

raised margin forms around the outer edge while the center sometimes becomes depressed, and assumes a light tan or brownish color. Pycnidia sometimes show in the depressed, lighter-colored area; they are black, and a mere fraction of a millimeter in diameter. The lesion not only occurs on the surface but extends into the skin tissue for 1 or as much as 2 millimeters. In this internal tissue the lesion is usually lighter colored—the reddish brown of a young lesion. The lesion has never been observed to extend into the flesh of the fruit, although rarely secondary rots, emanating from a black-spot lesion as the original point of infection, may progress into the flesh. The colored photograph, Plate 1, shows the disease much better than a written description can do.

The disease is not abundant on fruits in the orchard, but seems to develop while they are in storage, or in transit to markets. We have shipped fruits entirely unblemished, which on unpacking one month later were found severely affected by this black spot. The injury to the crop is much the same as that of citrus canker on fruits, and is due to a blemish which lessens its selling value. In a very few cases, the black-spot lesions afford an entrance for rot fungi, but such cases are rare.

## DISTRIBUTION

This disease has been observed at Canton, Hongkong, Swatow, Amoy, and Foochow in China. Specimens which emanated from Shanghai have been intercepted by the plant-quarantine inspectors at Nagasaki. Chinese fruits have been collected on the markets in Manila, which were severely affected by this disease, but Philippine-grown fruits have not been observed as yet to be affected. McAlpine, of course, originally reported the disease from New South Wales. The disease has not yet been observed in Japan nor has it been reported from California, Arizona, Florida, or the Gulf States. The distribution on the China coast as far north as Foochow would indicate that the development of the fungus is not limited by the lower temperatures of citrus-growing regions. That is to say, black spot of citrus fruits would seem to be a temperate zone disease.

## ISOLATION AND INOCULATION EXPERIMENTS

Isolation experiments were first attempted in Nagasaki, and a fungus was obtained uniformly from such isolations. Subsequently isolations were also made from Chinese fruits found on the Manila markets, and a fungus was isolated which on comparison with cultures from Nagasaki proved to be identical. The fungus answered closely to McAlpine's description of *Phoma citricarpa.*

Inoculation experiments were taken up in Manila; all necessary precautions were taken to maintain such inoculations under quarantine, although the presence of severely affected Chinese fruits in the distant provincial markets were an almost constant source of infection of Philippine-grown fruits had conditions been favorable for infection. The preliminary series of inoculations are here tabulated with the results obtained. The fruits were first disinfected with alcohol, and both control and fungus inoculations were made with needle punctures. All of the fruits were then held in a chamber maintained at laboratory temperatures (from 29° to 32° C.) and with slightly increased atmospheric moisture.

TABLE 1.—*Inoculations on mature Washington navel oranges, with tap water as controls, and with pure culture of Phoma citricarpa.*

[Inoculated April 14, 1920; date of observation of results, May 9, 1920.]

| Fruit No. | Punctures per fruit. | Inoculum. | Positive results. |
|---|---|---|---|
| | | | *Per cent.* |
| 1 | 20 | Tap water | 0 |
| 2 | 20 | do | 0 |
| 3 | 20 | do | 0 |
| 4 | 20 | *Phoma citricarpa* culture | 80 |
| 5 | 20 | do | 70 |
| 6 | 20 | do | 95 |

The lesions obtained by these inoculations with the fungus were usually dead black in the center, becoming a deep brown at the edges (Plate 2). The fruits could not be held as long as was desirable because of the quick infection with rotting fungi in the warm Manila conditions; fruiting bodies were not found on the surface of the positive cases in the twenty-four days during which the fruits were held. Reisolation, however, on agar plates resulted in the recovery of the fungus in the five cases tried.

Inoculations with the fungus and controls with tap water made at the same time on six similar Washington navel oranges, but held at a temperature varying closely around 12° C., in all cases were negative. This was attempted for the reason that it was feared that the normal Manila temperatures might be too high for positive infection. The result showed that this was not the case but the instance is presented as of possible value to a future investigator.

Reinoculations were then made on Washington navel oranges. These inoculations were made in two lots; (1) inoculated fruits held in a moist chamber with controls, and (2) fruits held at the normal laboratory atmospheric humidity of Manila in May; the normal humidity in May is not high. The fruits were disinfected with alcohol as previously, and both controls and fungus inoculations were made with needle punctures. The results are shown in Table 2.

TABLE 2.—*Inoculations on mature Washington navel oranges, with tap water for controls, and with pure culture of Phoma citricarpa.*

[Inoculated May 21, 1920; date of observation of results, June 9, 1920.]

| Fruit No. | Punctures. | Inoculum. | Conditions of humidity. | Positive results. |
|---|---|---|---|---|
| | | | | *Per cent.* |
| 1 | 20 | Tap water | Dry laboratory | 0 |
| 2 | 20 | do | do | 0 |
| 3 | 20 | do | do | 0 |
| 4 | 20 | do | Moist chamber | 0 |
| 5 | 20 | do | do | 0 |
| 6 | 20 | do | do | 0 |
| 7 | 20 | *Phoma citricarpa* | Dry laboratory | 0 |
| 8 | 20 | do | do | [a] 65 |
| 9 | 20 | do | do | [a] 10 |
| 10 | 20 | do | Moist chamber | [b] 5 |
| 11 | 20 | do | do | [b] 25 |
| 12 | 20 | do | do | [b] 75 |

[a] Doubtful lesions. [b] Clearly positive.

Table 2 shows that under dry atmospheric conditions the fungus produces no lesion, or lesions which are very doubtful. With increased atmospheric moisture, 35 per cent of the inoculation punctures were positive; the lesions under such conditions were dead black in the center, becoming slightly reddish toward the margins and varying in diameter from 1 to 3 millimeters. They were in most cases typical black-spot lesions. The fungus was reisolated from the positive lesions. Control punctures with tap water remained entirely negative and in many cases healed so as to be unnoticeable.

Inoculation experiments have been repeated several times since these original results and always, under moderately humid conditions, a reasonable percentage of positive results was produced.

### THE FUNGUS IN CULTURE

The fungus grows slowly on the artificial media tried, and is not always easily isolated because of the ease with which secondary fungi may outgrow it. Beef agar + 1, glucose agar + 1, and potato plugs have been used for culturing this fungus; on all of them the fungus makes a restricted growth. The early mycelium is grayish, but the colony soon becomes dead black due to the formation of pycnidia; the colonies are small and restricted (Plates 3 and 4). Pycnidia appear within six or seven days after planting and are abundant, black, spherical, and with pores indistinct.

Under the microscope the young hyphae are hyaline and distantly septate, but with age the hyphae become dark olive brown, closely septate, and twisted and swollen. Spores are borne apically on slender, hyaline conidiophores, and are hyaline, single-celled, smooth and thin-walled, ovate, sometimes becoming almost pyriform, noticeably granular (Plate 4, fig. 2); from cultures they vary in size from 9.25 to 12.25 $\times$ 5.5 to 8.1 $\mu$. Spores are not formed profusely. The diagnostic features are the black, carbonaceous, restricted growth in culture and the thin-walled, granular, and somewhat individualistic spores. The best determination of the fungus is its pathogenicity on sweet oranges which may be visible in from fifteen to twenty days. The fungus agrees closely with McAlpine's excellent description of *Phoma citricarpa,* and we consider it identical.

### HOSTS

McAlpine describes this black-spot disease on oranges, lemons, and mandarin oranges. The writer's inoculations on lemons in Manila have always resulted negatively; for such experiments mature California lemons were used, probably the Lisbon or Eureka variety or both, purchased in the Manila markets. It may be that these California varieties are not so susceptible as are those grown in Australia. The writer is of the opinion, however, that Manila temperatures are somewhat above the optimum desirable for this fungus, and that inoculations at lower temperatures might produce different results on lemons. Man-

175542——8

darin oranges have given positive results in Manila; we have no data as yet for other species of *Citrus*.

## CONTROL

There are no experimental data regarding control of this disease in an affected orchard. The writer's inoculations have shown that fruits are only susceptible when approaching maturity, while immature fruits give negative results when inoculated. It is possible, therefore, that an easy orchard control, by spraying, could be developed.

For countries where the disease is not yet present, however, as in California, the Gulf States of America, and Japan, the best control is of course entire prevention by excluding the disease. The best of control methods by spraying are not 100 per cent efficient and in addition cause an annual outlay which is repeated year after year. Exclusion of the fungus by the plant-quarantine officers would be 100 per cent control and would cost but a small amount as compared with the yearly outlay for spraying.

The situation in the Philippines with regard to this disease is peculiar. Black-spot disease, as has been said, has not been observed here as yet upon Philippine-grown oranges. Oranges imported from China and found everywhere on the markets are sometimes severely affected with the disease, affording a source of infection of Philippine citrus fruits just at the period when such fruits are ripening. The absence of the disease in the Philippines is therefore probably due to climatic conditions or possibly to the phenomenon that ordinarily the rind of Philippine citrus fruits does not mature and turn yellow, but remains green up to picking time. Since citrus fruits are only susceptible when the rind is well matured, the absence of the disease may be due to the absence of susceptible tissue. This point may be cleared up in future experiments.

## SUMMARY

1. Black spot, a disease described by McAlpine from Australia in 1899, has also been observed throughout southern China. It is not yet in Japan or America or in the orchards in the Philippines. The disease consists of a black blemish on the fruits; it is not found on the leaves or branches.

2. The fungus *Phoma citricarpa* McAlpine was isolated from black-spot lesions and, on inoculation upon healthy orange fruits, reproduced the disease. Control punctures remained negative.

The fungus was reisolated in culture from the positive inoculations. Inoculations have since been made a number of times resulting positively in reasonable percentages of cases, indicating that *Phoma citricarpa* is the cause of the black-spot lesions. *Phoma citricarpa* is briefly described from cultures.

3. The sweet orange and mandarin orange fruits were observed to be affected in China. McAlpine also reports lemons to be affected. Other citrus species have not been observed to be affected. The activity of the disease is not limited by the low temperatures of the northernmost citrus-growing regions.

4. Although the disease is not serious and moreover could probably be prevented by spraying methods, it is desirable, in order to avoid the cost of spraying methods, to exclude it entirely from such citrus-growing countries in which it has not yet appeared. The present paper calls attention to the desirability of exclusion for such countries as Japan, California, and Florida.

# ILLUSTRATIONS

## PLATE 1

Black spot on fruits of Chinese mandarin orange variety. The spots are caused by the fungus *Phoma citricarpa* McAlpine.

## PLATE 2

FIG. 1. Washington navel orange on which twenty needle punctures have been made with tap water.

2. Washington navel orange on which twenty needle punctures were made with an infusion of *Phoma citricarpa*. Both fruits were inoculated at the same time and held under the same conditions.

## PLATE 3

FIG. 1. *Phoma citricarpa* on glucose agar slant, showing black restricted growth; twenty days from planting.

2. *Phoma citricarpa* on potato plug; twenty days from planting.

## PLATE 4

FIG. 1. *Phoma citricarpa* on a plate of standard nutrient beef agar + 1, fourteen days after planting, showing restricted growth; natural size.

2. Conidiophores and conidia of *Phoma citricarpa* McAlpine, × 500.

PLATE 1. BLACK SPOT ON FRUITS OF CHINESE MANDARIN ORANGE VARIETY. THE SPOTS ARE CAUSED BY THE FUNGUS PHOMA CITRICARPA MCALPINE.

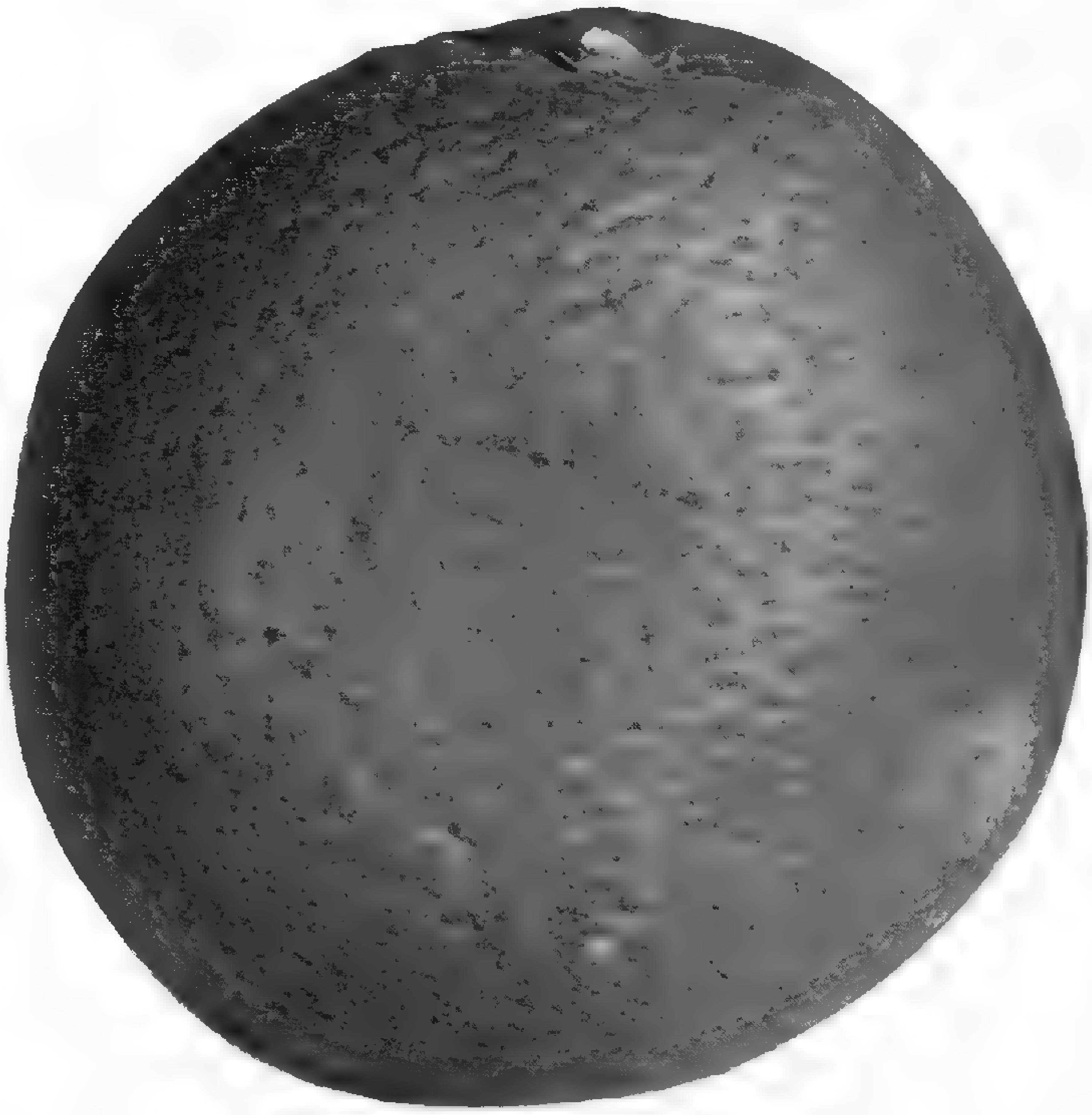

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Fig. 1. Washington navel orange on which twenty needle punctures have been made with tap water. 2. Washington navel orange on which twenty needle punctures have been made with an infusion of Phoma citricarpa. Both fruits were inoculated at the same time and held under the same conditions.

PLATE 2.

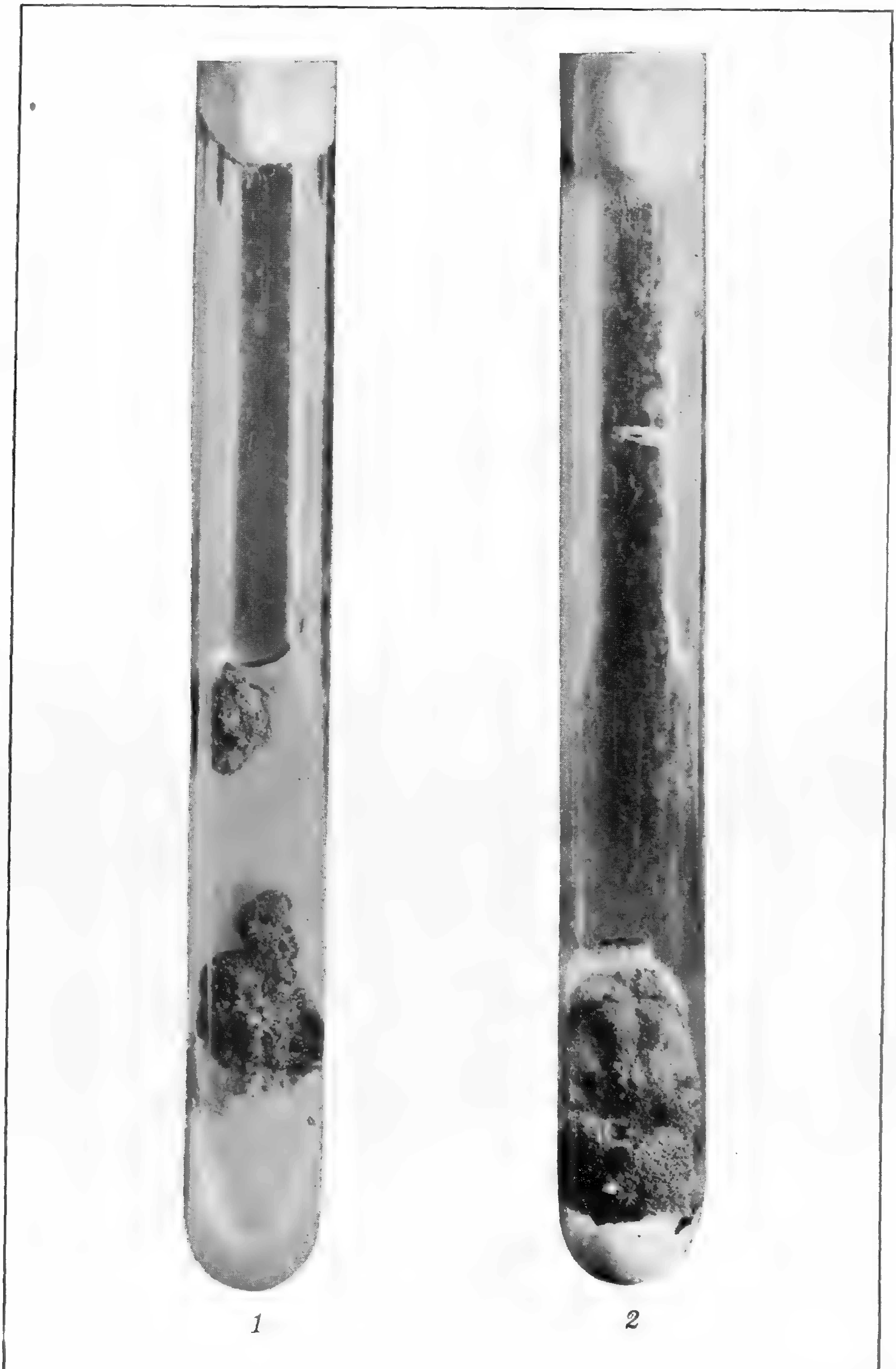


Fig. 1. Phoma citricarpa on glucose agar slant, showing black restricted growth; twenty days from planting. 2. Phoma citricarpa on potato plug; twenty days from planting.

PLATE 3.

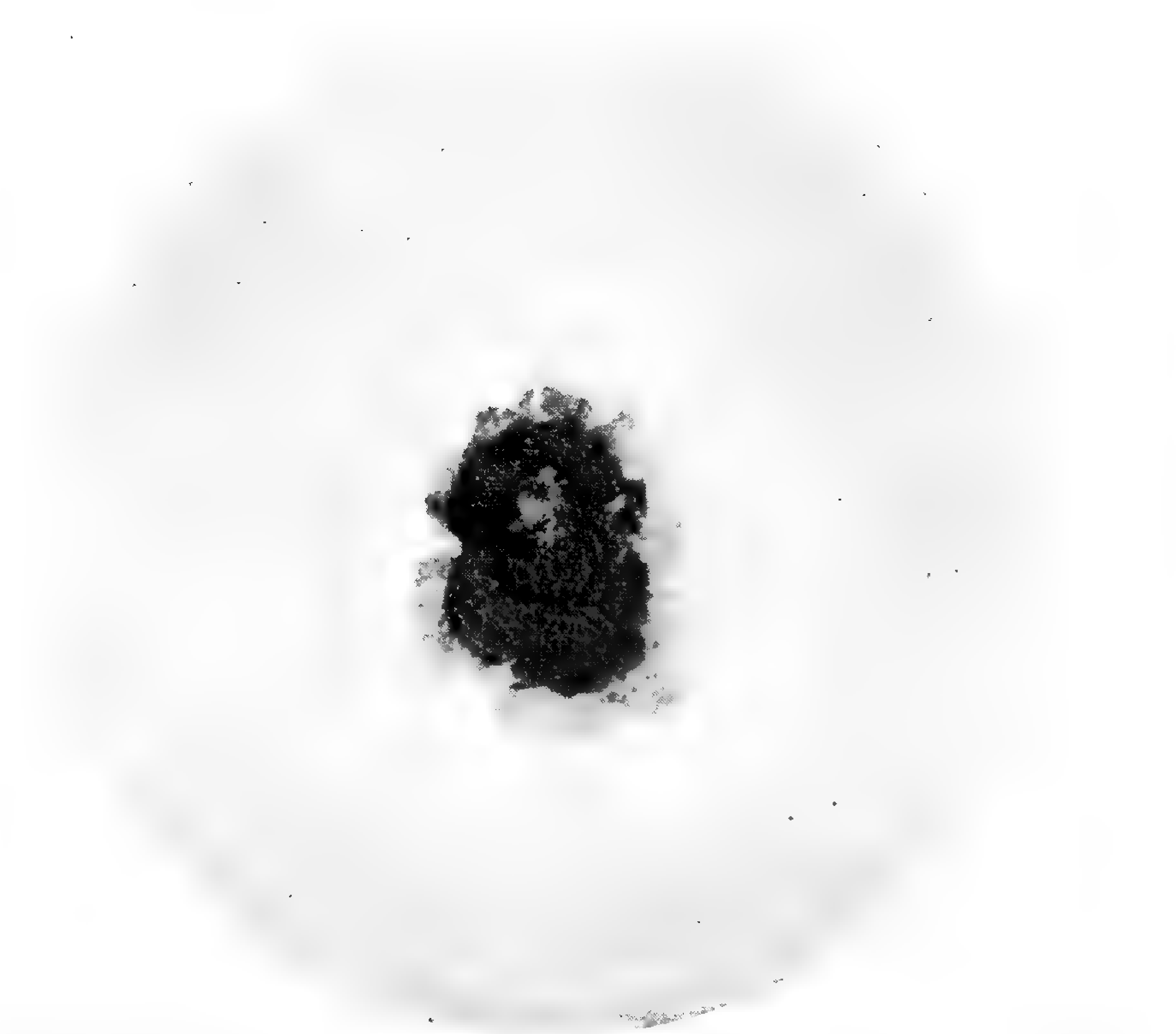

Fig. 1. Phoma citricarpa on a plate of standard nutrient beef agar + 1, fourteen days after planting, showing restricted growth; natural size.

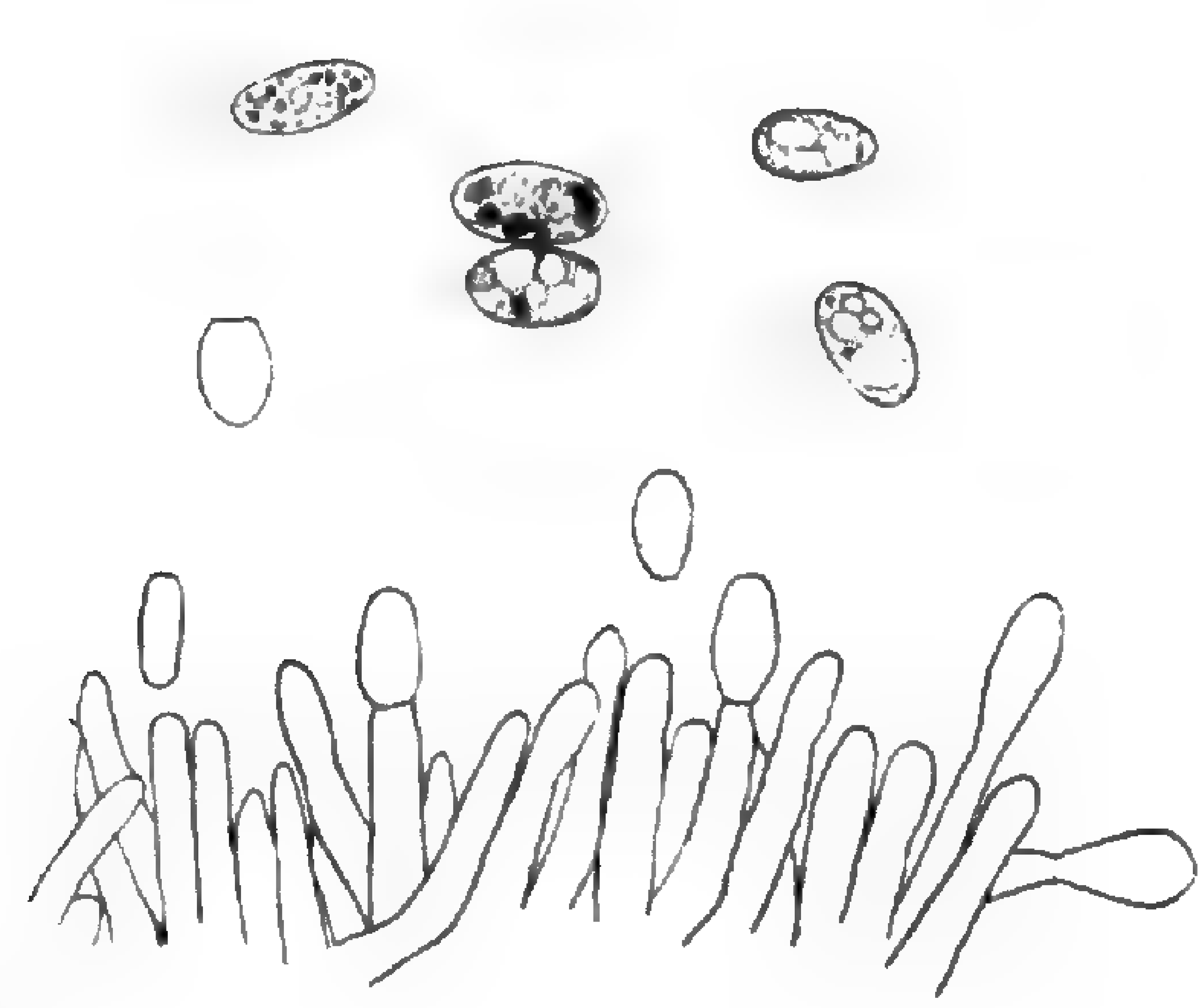

Fig. 2. Conidiophores and conidia of Phoma citricarpa McAlpine, × 500.

PLATE 4.

## ERRATA

Page 337, line 32, *for* .05 cubic centimeter *read* 0.5 cubic centimeter.

# INDEX

[New generic and specific names and new combinations are printed in **clarendon**; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

## D

## M

## P

## Q

## R



## S