Bulletin No. 196

1929

Agricultural Research Institute, Pusa

THE COTTON WHITE-FLY
(*Bemisia gossypiperda*, n. sp.)

BY

RAI BAHADUR C. S. MISRA, B.A.
First Assistant to the Imperial Entomologist
AND
KARAM SINGH LAMBA, M.Sc.
Post Graduate Student in Entomology, Agricultural Research Institute, Pusa

CALCUTTA: GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1929

Government of India Publications are obtainable from the Government of India Central Publication Branch, 3, Government Place, West, Calcutta, and from the following Agents :—

EUROPE.

OFFICE OF THE HIGH COMMISSIONER FOR INDIA, 42, GROSVENOR GARDENS, LONDON, S. W. 1.

And at all Booksellers.

INDIA AND CEYLON : Provincial Book Depôts.

MADRAS :—Superintendent, Government Press, Mount Road, Madras.
BOMBAY :—Superintendent, Government Book Depôt, Town Hall, Bombay.
SIND :—Library attached to the Office of the Commissioner in Sind, Karachi.
BENGAL :—Bengal Secretariat Book Depôt, Writers' Buildings, Room No. 1, Ground Floor, Calcutta.
UNITED PROVINCES OF AGRA AND OUDH :—Superintendent of Government Press, United Provinces of Agra and Oudh, Allahabad.
PUNJAB :—Superintendent, Government Printing, Punjab, Lahore.
BURMA :—Superintendent, Government Printing, Burma, Rangoon.
CENTRAL PROVINCES AND BERAR :—Superintendent, Government Printing, Central Provinces, Nagpur.
ASSAM :—Superintendent, Assam Secretariat Press, Shillong.
BIHAR AND ORISSA :—Superintendent, Government Printing, Bihar and Orissa, P. O. Gulzarbagh, Patna.
COORG :—Office of the Chief Commissioner of Coorg, Bangalore.
NORTH-WEST FRONTIER PROVINCE :—Manager, Government Printing and Stationery, Peshawar.

Thacker Spink & Co., Calcutta and Simla.
W. Newman & Co., Ltd., Calcutta.
R. Cambray & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
The Indian School Supply Depôt, 309, Bow Bazar Street, Calcutta.
Butterworth & Co. (India), Ltd., Calcutta.
Rai M. C. Sarcar Bahadur & Sons, 90-2A, Harrison Road, Calcutta.
Standard Literature Company, Limited, Calcutta.
Association Press, Calcutta.
Chukervertty, Chatterjee & Co., Ltd., 13, College Square, Calcutta.
The Book Company, Calcutta.
James Murray & Co., 12, Government Place, Calcutta. (For Meteorological Publications only.)
Ray Chaudhury & Co 68-5, Ashutosh Mukerji Road, Calcutta.
Scientific Publishing Co., 9, Taltola Lane, Calcutta.
Chatterjee & Co., 294, Cornwallis Street, Calcutta.
Standard Law Book Society, 8-2, Hastings Street, Calcutta.
The Hindu Library, 3, Nandalal Mullick Lane, Calcutta.
B. C. Basak, Esq., Proprietor, Albert Library, Dacca.
Mitra Brothers, Rajshahi.
Higginbothams, Madras.
P. R. Rama Iyer & Co., Madras.
Rochouse Sons, Madras.
G. A. Nateson & Co., Publishers, George Town, Madras.
Theosophical Publishing House, Adyar, Madras.
P. Varadachary & Co., Madras.
S. Murthy & Co., Madras.
Bright & Co., Trivandrum.
The Booklover's Resort, Taikad, Trivandrum, South India.
E. M. Gopalakrishna Kone, Pudumandapam, Madura.
Central Book Depôt, Madura.
Vijapur & Co., Vizagapatam.
Thacker & Co., Ltd., Bombay.
D. B. Taraporevala, Sons & Co., Bombay.
Sunder Pandurang, Bombay.
Ram Chandra Govind & Sons, Kalbadevi Road, Bombay.
N. M. Tripathi & Co., Booksellers, Princess Street, Kalbadevi Road, Bombay.
New and Secondhand Bookshop, Kalbadevi Road, Bombay.
Mrs. Radhabai Atmaram Sagoon, Kalbadevi Road, Bombay.
A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.
S. Govind & Co., Sandhurst Road, Girgaum, Bombay.
J. M. Pandia & Co., Bombay.
Proprietor, New Kitabkhana, Poona.
The Manager, Oriental Book Supplying Agency 15, Shukrawar, Poona City.
Rama Krishna Bros., Opposite Vishrambag, Poona City.
S. P. Bookstall, 21, Budhwar, Poona.
Mangaldas & Sons, Booksellers and Publishers, Bhaga Talao, Surat.
The Standard Book and Stationery Co., 32-33, Arbab Road, Peshawar.
V. B. Umadikar & Co., The Bharat Book Depôt, Dharwar.
The Standard Bookstall, Karachi, Quetta, Delhi, Murree and Rawalpindi.
The Karachi Book Depôt, Elphinstone Street, Camp, Karachi.
The English Bookstall, Karachi.
The Standard Bookstall, Quetta.
U. P. Malhotra & Co., Quetta.
J. Ray & Sons, 43, K. & L., Edwardes Road, Rawalpindi, Murree and Lahore.
The Standard Book Depôt, Lahore, Nainital, Mussoorie, Dalhousie, Ambala Cantonment and Delhi.
N. B. Mathur, Supdt., Nazir Kanun Hind Press, Allahabad.
The North India Christian Tract and Book Society, 18, Clive Road, Allahabad.
Ram Dayal Agarwala, 184, Katra, Allahabad.
The Indian Army Book Depôt, Jubbulpore, Cawnpore.
The Indian Army Book Depôt, Jullunder City.
Manager, Newal Kishore Press, Lucknow.
The Upper India Publishing House, Ltd., Literature Palace, Aminuddaula Park, Lucknow.
Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Allahabad.
Rama Krishna & Sons, Booksellers, Anarkali, Lahore.
Puri Brothers, Booksellers and Publishers, Katcheri Road, Lahore.
The Tilak School Bookshop, Lahore.
The Standard Bookstall, Lahore.
The Proprietors, Punjab Sanskrit Book Depôt, Saidmitha Street, Lahore.
The Insurance Publicity Co., Ltd., Lahore.
The Punjab Religious Book Society, Lahore.
Manager of the Imperial Book Depôt, 63, Chandney Chawk Street, Delhi.
Fono Book Agency, New Delhi.
Oxford Book and Stationery Company, Delhi and Calcutta.
Supdt., American Baptist Mission Press, Rangoon.
The Modern Publishing House, Ltd., 30, Phayre Street, Rangoon.
Burma Book Club, Ltd., Rangoon.
Manager, The "Hitavada," Nagpur.
Bhisey Brothers, Booksellers and Stationers, Sitabaldi, Nagpur.
S. C. Talukdar, Proprietor, Students & Co., Cooch Behar.
The Manager, Ceylon Observer, Colombo.
The Manager, The Indian Book Shop, Benares City.
The Srivilliputtur Co-operative Trading Union, Ltd., Srivilliputtur (S. I. R.)
Raghunath Prasad & Sons, Patna City.
The Student's Emporium, Patna.
K. L. Mathur & Bros., Guzri, Patna City.
Dandekar Brothers, Indore City.
Pustakalaya Sahayak Sahakari Ltd., Baroda.
The Hyderabad Book Depôt, Chaderghat, Hyderabad (Deccan).
Thakur & Co., Amraoti.
S. Krishnaswami & Co., Teppakulam P. O., Trichinopoly Fort.
National College Teachers, Union Book Depôt, Trichinopoly.

The Cotton White-Fly.

(*Bemisia gossypiperda*, n. sp.)

(Received for publication on 12th February 1929.)

The Cotton White-fly was noticed for the first time on cotton in Bihar in the year 1905, when varieties of cotton were grown on the Pusa Farm to test their suitability for adoption in North Bihar, where the cultivation of indigo had fallen off owing to the introduction of synthetic indigo. It was then, as now, noticed to be present more on the broad-leaved varieties of cotton than the short-leaved ones. Since then it has been present on cotton at Pusa but not to any large extent so as to be considered as a pest. The Economic Botanist to the Government of the Punjab noticed it on cotton at Lyallpur in the year 1915. In 1925 it was again found in numbers on cotton in the neighbourhood of Lyallpur in the Punjab. Of late it has been much in evidence on cotton and especially in the Punjab. It has also been present to a large extent on the Farm of the British Cotton Growing Association (Punjab) Ltd., Khanewal, and the cause of the diminishing outturns of cotton on that Farm has been attributed to the abnormal presence of the cotton white-fly—*Bemisia gossypiperda*, n. sp., on cotton, especially the broad leaved varieties 4 F., 285 F. and 289 F. In July last year the Director of the British Cotton Growing Association (Punjab) Ltd., wrote thus to the Imperial Entomologist :—

"*** In view of the very considerable financial losses which Zamindars have suffered in this locality in the past, amounting to 4 to 10 maunds (Rs. 56 to Rs. 140) per acre, we trust you will give the matter the attention which it appears to us to merit. We may inform you that we are prepared to undertake an intensive campaign against this pest on all our cotton crops provided you can furnish us with the technical advice which we now seek." Three months later, the Director of the same company wrote to the Imperial Entomologist, Pusa :—

"*** In this it may interest you to know that the undersigned suspected during the early part of the cotton season that this Aleyrodid pest may well be responsible for the considerable amount of damage done to the cotton crop in the locality during the past two seasons and he anticipated a recurrence of the damage in the present season. He has now arrived at the definite conclusion that the primary cause of this

damage which results in the depreciation of the cotton crop in this part of the Punjab to the extent of crores of rupees annually is the white-fly. *** We are prepared to expend considerable sums in the eradication of this pest and we are particularly desirous of gathering all possible information in time to enable us to take comprehensive, preventive and remedial measures for the next season crop."

The White-fly lays eggs preferably on the lower surfaces of leaves. Up to now, an adult female has been found to deposit 28-35 eggs. When a large number of flies oviposit on the same leaf, it becomes covered with innumerable, pale-yellow pedunculated eggs broad at base and tapering apically (Plate I, fig. 1). Twenty-four hours after deposition the egg turns pale brown and a tiny light yellow larva (Pl. I, fig. 2) crawls about on the leaf for some hours in search of a succulent spot, after which it settles down, secretes a narrow waxy fringe and starts feeding by sucking the leaf sap. The larvae pass through four instars (Pl. I, figs. 2, 3, 4 5) and the fourth instar passes directly into the pupal stage without a moult there being no clear demarcation between the last larval and the pupal instars. All the larval stages of the White-fly are passed on the host plant (Pl. I, figs. 3, 4, 5). If the underside of a cotton leaf be turned over and examined with a hand-lens—even magnifying diameters x8—it will be seen that it is studded with small pale yellow protuberances not larger than a pin head (Pl. I, fig. 11). In case of severe infestation of the cotton leaves not even a milimetre of leaf space is free from some stage of the pest. Each larva thrusts its proboscis into the tissue of the leaves and drains away the sap which should have gone to mature the bolls. Thus the plant nutrition is considerably hampered, the leaves, unable to respond to the drain of sap by myriads of insects, fall off prematurely, and the bolls, if they open at all, remain half opened on the plants. In some varieties of cotton, especially 4 F. of the Punjab, it has been noticed that the petioles of infested leaves become so weak that with the least touch or disturbance they fall off. It has also been noticed that the strength of fibre undergoes considerable deterioration. It not only shrivels up but loses its tensility also. In fact the crop in the affected locality gives diminishing outturns and the loss to the ryot is great. The affected fields present a blighted appearance and this is very prominent when broad-leaved varieties such as the Punjab 4 F., 285 F. and 289 F. are grown alongside of short-leaved varieties such as the Punjab *mollisoni* and Punjab *sanguineum*. In a recent examination of cotton on the British Cotton Growing Association Farm, Khanewal, Punjab, it was noticed that plots with 4 F. appeared blighted in comparison with *sanguineum* grown side by side. It was further noticed on

PLATE I.

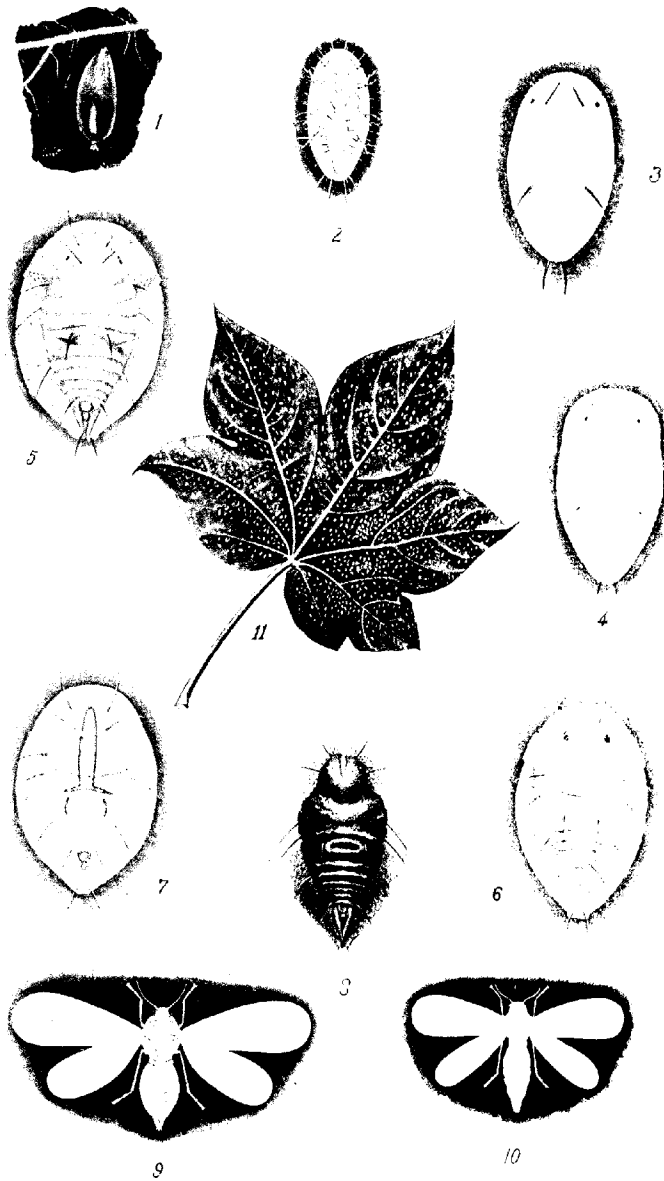
THE COTTON WHITE-FLY.

Fig. 1.—Egg ... ... × 100
Fig. 2.—Larva 1st instar ... ... × 100
Fig. 3.—Larva 2nd instar ... ... × 100
Fig. 4.—Larva 3rd instar ... ... × 80
Fig. 5.—Larva 4th instar ... ... × 54
Fig. 6.—Pupa ... ... × 54
Fig. 7.—Empty Pupa Case ... ... × 54
Fig. 8.—Parasitized puparium ... ... × 54
Fig. 9.—Male ... ... × 27
Fig. 10.—Female ... ... × 27
Fig. 11.—Leaf infested with larvæ and puparia

PLATE I.

THE COTTON WHITE-FLY.

FIG. 1.—Egg ... ... × 100
FIG. 2.—Larva 1st instar ... ... × 100
FIG. 3.—Larva 2nd instar ... ... × 100
FIG. 4.—Larva 3rd instar ... ... × 80
FIG. 5.—Larva 4th instar ... ... × 54
FIG. 6.—Pupa ... ... × 54
FIG. 7.—Empty Pupa Case ... ... × 54
FIG. 8.—Parasitized puparium ... ... × 54
FIG. 9.—Male ... ... × 27
FIG. 10.—Female ... ... × 27
FIG. 11.—Leaf infested with larvæ and puparia



Bemisia gossypiperda.

this farm that of all the broad-leaved varieties of cotton 1 F. was the worst sufferer. It seemed to be especially susceptible to the attack of the White-fly. Plots with 4 F. cotton in them were bare, whilst *sanguineum* grown close to these were green and healthy with plenty of bolls on them. From what has hitherto been studied of the pest so far it appears that the White fly reaches its maximum development by the end of August when the majority of plants become infested. At first this is not apparent as the larvæ and pupæ are concentrated on the lower surface of leaves. From July onwards the White fly continues to multiply thereby considerably lowering the vitality of the plants. At Khanewal as many as 529 larvæ and pupæ were found in a square inch on Bhindi (*Hibiscus esculentus*) leaves. At Pusa 260 larvæ were found to the square inch on cotton leaves received from Khanewal for examination.

The pupæ, along with the larvæ, remain on the lower surface of the leaves. When the pupa is fully matured, the imago within becomes plainly visible. The two red spots, which develop, represent the eyes of the developing imago within it (Pl. I, fig. 6). When about to emerge a T-shaped slit appears on the dorsum (Pl. I, fig. 7) and the adult comes out with crumpled wings. After 10 to 15 minutes the wings become fully expanded and the adult moves away. The duration of each instar varies from 3 to 4 days and the total life cycle, from the egg to the adult, lasts from 12 to 17 days in August and September when the average mean temperature is 84°F. and the average mean humidity is 87 per cent. The adults are tiny active creatures with creamy yellow bodies, a pair of wings covered with a whitish meal and a pair of deep maroon eyes. The male (Pl. I, fig. 10) is smaller than the female (Pl. I, fig. 9) and is readily distinguished by a pair of claspers at the abdominal end.

Besides cotton, the White-fly, *Bemisia gossypiperda*, n. sp., has hitherto been noticed on the following alternative food plants:—

Turnip (*Brassica campestris* var *rapa*); mustard (*Brassica campestris*); brinjal (*Solanum melongena*); potato (*Solanum tuberosum*); Bhindi leaves (*Hibiscus esculentus*); cauliflower (*Brassica oleracea*); cabbage (*Brassica oleracea capitata*); Cape gooseberry (*Physalis peruviana*); Palwal (*Trichosanthes dioica*); Phoont (*Cucumis Melo*); senji (*Cleome viscosa*); Bhat Katai (*Solanum xanthocarpum*); Dudhi (*Euphorbia pilulifera*); Tetari (*Launia asplenifolia*); Chichra (*Achyranthes aspera*); Banka (*Lippia geminata*); Pitha (*Trewia nudiflora*); Harsingar (*Nyctanthes arbortristis*); Bhant (*Clerodendron infortunatum*); Indrayan (*Citrullus colocynthis*); and *Corchorus trilocularis*.

Of these, it has been found to breed in large numbers on Bhindi (*Hibiscus esculentus*); brinjal (*Solanum melongena*); Palwal (*Trichosanthes dioica*) and the Cape gooseberry (*Physalis peruviana*).

Hitherto the parasitization observed in the species has been very small. Only two species of *Chalcidoid* parasites have been bred out. The parasitized pupæ (Pl. I, fig. 8) turn dark grey or black, and the parasite emerges by making a clean circular hole mainly in the anterior part of the pupa. The amount of parasitization, as hitherto ascertained from material obtained through the courtsey of Mr. Robert Thomas of the British Cotton Growing Association (Punjab) Ltd., Khanewal, varies from 4 to 6 per cent. only. With an intensive study of the pest, extended over a wide range it might be possible to find a larger parasitization of the species in any locality which could then be used as a centre for the breeding and subsequent despatch of natural parasites to the infested localities.

The Cotton White-fly has hitherto been found at Pusa, Lyallpur and Khanewal in the Punjab. In the latter place it has been bad for the last three years. It is possible that the serious attack of the Cotton White-fly is only a passing phase, just as has been the case in the past with the rice leaf-hoppers *Nephotettix bipunctatus* *, Fabr., and *Nephotettix apicalis*, Motsch., in the Chhattisgarh division of the Central Provinces. It is possible, as was the case with the Rice Leaf-hoppers, that with the automatic adjustment of climatic conditions, the White-fly on cotton might also disappear. If not, sustained drastic measures will have to be adopted to prevent the enormous loss annually caused by the White-fly to cotton. We, therefore, think that, if the attack persists, it would be worth while adopting the following measures against the White-fly.

1. Putting down selected trap crops during the quiescent period, especially from the beginning of March to the end of April and grubbing these up in time and burning them before the cotton sowings begin.

2. To sow varieties of cotton as late as possible so as to escape the maximum infective period of the White-fly.

3. To evolve types of cotton which are more or less immune to the attack of the White-fly.

4. To sow short leaved varieties of cotton in place of broad leaved ones, which are more susceptible to the attack of the White-fly.

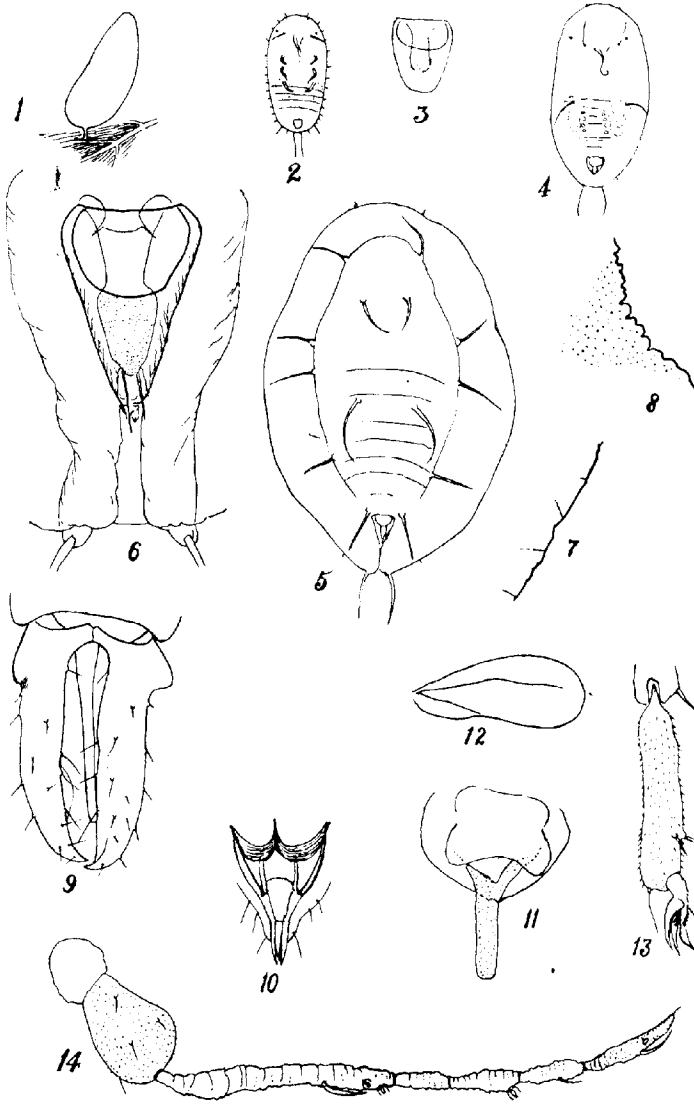
* Misra, C. S.—The Rice Leaf-hoppers *Nephotettix bipunctatus*, Fabr. and *Nephotettix apicalis*, Motsch. *Mem. Dept. Agri. India, Ent. Series*, Vol. V, No. 5.

PLATE II.

PLATE II.

The Cotton White-Fly.

Fig. 1.	—Egg	× 126
Fig. 2.	—Larva 1st instar	× 110
Fig. 3.	—Larva 1st instar : vasiform orifice	× 600
Fig. 4.	—Larva 2nd instar	× 110
Fig. 5.	—Pupa case	× 110
Fig. 6.	—Vasiform orifice of pupa case	× 600
Fig. 7.	—Margin of pupa case	× 600
Fig. 8.	—End of thoracic tracheal fold	× 600
Fig. 9.	—Male Genitalia (external)	× 600
Fig. 10.	—Female Genitalia (chitinized parts)	× 600
Fig. 11.	—Female vasiform orifice	× 600
Fig. 12.	—Male fore wing	× 55
Fig. 13.	—Male hind tarsus and claws	× 600
Fig. 14.	—Male antenna	× 600



The Cotton White-Fly.

5. To spray cotton fields with power sprayers with especial arrangement to wet under surface of leaves when the plants are from 12" to 14" high.

6. Introduction of parasites and predators which would keep down the pest. Hitherto the parasitization has been found to vary from 4 to 6 per cent. but with intensive study of the pest over a wide range it may be possible to fix upon a locality where the parasitization of the species is fairly high.

Bemisia gossypiperda, n. sp., is new to cotton and as such there is hardly any literature extant on the pest. We, therefore, describe it in full for the sake of ready reference.

The egg (Pl. II, fig. 1). is laid promiscuously on the lower surface of leaves. It is sub-oval in form with a short peduncle arising from the broad end. Chorion smooth and shiny without any sculpture. When laid freshly it is pale, translucent white. Twenty-four hours after it turns brownish yellow. Seventy-two hours after a pair of reddish spots, representing the eyes of the developing larva within, appear. Length ·175 mm., breadth ·081 mm., length of peduncle ·019 mm.

Empty pedunculated eggs broad at base and pointed apically remain attached to the leaf with a longitudinal slit on them.

Larva first instar (Pl. II, fig. 2). Size ·266 mm. by ·133 mm., pale translucent white; mycetoma greenish yellow; eyes crimson, divided; shape elliptical with a narrow waxy fringe broken into bands all round the margin which is almost entire with 16 pairs of hairs on tubercles, 3 pairs on the cephalic, 3 on the caudal, the remaining small, laterally; the first and the third caudal pairs being longer than the remaining ones. A minute pair of hairs on cephalic submargin. Dorsal disk with the abdominal segments distinct. Vasiform orifice (Pl. II, fig. 3) ·023 mm. by ·027 mm., sub-trapezoidal, operculum sub-semicircular, filling about half the orifice, leaving about half of the spatulate, setose lingula exposed. Legs and antennæ ordinary.

Larva second instar (Pl. II, fig. 4). Colour and shape as in the previous instar; ·342 mm. by ·152 mm. size; eyes undivided, margin finely crenulate with only three pairs of hairs, a minute pair on the cephalic, a long pair on prominent tubercle on the caudal, and a minute pair on the caudo-lateral margin. Dorsal disk with two pairs of long spine-like hairs, one pair laterad of the base of the mouth parts and the second pair near the anterior margin of the mycetoma. Intad of the mycetoma there is a row of about half a dozen circular, translucent spots on each side. Vasiform orifice and operculum as in the previous stage-lingula with a pair of hairs at the distal end. Conical rudiments of legs present; antennæ absent.

Larva third instar (Pl. I, fig. 4). ·475 mm. by ·285 mm. in size; sub-oval in outline; margin crenulate with only a single pair of hairs on tubercles at the caudal end. Vasiform orifice triangular with the cephalic margin straight; operculum sub-semicircular, filling about half the orifice leaving about half of the spatulate, setose lingula exposed, distal extremity of the lingula provided with a pair of hairs touching the side of the vasiform orifice. The rest of the details as in the previous instar.

Larva fourth instar and pupa (Pl. I, figs. 5 & 6). The fourth instar passes into the pupal stage without a moult and in consequence differs little from the puparium, only it is flat owing to the absence of the developing imago within.

On a leaf the pupæ are convex, sub-elliptical with shallow indentures on the cephalothoracic and the caudal margins. Colour light yellowish; a pair of deep yellow pigmented patches on the abdomen and a flavous tinge at the end of the thoracic and the caudal tracheal folds, which have a narrow waxy fringe, the rest of the margin being without it; operculum brownish. Eyes of the developing imago within deep maroon.

Empty pupal cases (Pl. I, fig.7) are transparent under the microscope. Margin (Pl. II, fig. 7) finely crenulate, with deeper indentations (Pl. II, fig. 8) at the termination of the thoracic tracheal folds which are dotted and faintly indicated. Three pairs of hairs on the margin, a minute pair on the cephalic, a long pair on prominent tubercles on the caudal and a minute pair caudo laterad; dorsal disk indistinctly demarcated by a faint line from the sub-lateral parts; with abdominal segments, and with seven pairs of long, spine-like hairs on prominent tubercles; a pair in front of the eyes and a pair behind them, two sub-lateral pairs on the thorax, a sub-medial pair on the second abdominal segment, a sub-lateral pair on the fourth abdominal segment and a pair cephalo-laterad of the vasiform orifice (Pl. II, fig. 6) which is triangular with the cephalic margin straight and the edges with short longitudinal folds; operculum sub-semicircular, filling about half the orifice, leaving the sub-conical distal half of the setose lingula exposed; tip of lingula armed with a pair of spines; vasiform orifice bounded laterad by faintly demarcated area continuing caudad with a narrow groove from the end of the orifice to the caudal margin. Length of pupal case ·684 mm.; breadth ·494 mm.; length of vasiform orifice ·078 mm., breadth of vasiform orifice ·055 mm., length of operculum ·035 mm.

Adult female (Pl. I, fig. 9). Length from vertex to tip of ovipositor about 1·03 mm., light lemon—yellow in colour; eyes maroon, divided, body covered with fine, white meal. Antennæ of seven segments, segment I short, sub-globose; segment II sub-pyriform., ·051 mm. long,

provided with about half a dozen spines on tubercles; segment III sub-cylindrical, ·101 mm. long, imbricate, armed with two spiked sensoria and an ensiform spine near the distal end; segment IV much the same as the previous segment, ·019 mm. long; segment V club-like. ·031 mm. long with a spiked sensorium at the distal end; segment VI sub-cylindrical, ·027 mm. long, with a short spine near the distal end; segment VII sub-fusiform, ·039 mm. long imbricate proximally, profusely covered with minute hairs distally armed with an ensiform spine, a spiked sensorium and a minute seta at the tip.

Fore wing about ·79 mm. by ·22 mm., hyaline covered with a thin white meal; radial sector with an inconspicuous flexture, cubitus indicated as a hyaline streak. Hindwing concolorous, about ·68 mm. by ·28 mm.

Hind tibia ·304 mm.; proximal hind tarsus ·114 mm. distal tarsus ·057 mm.; claws ordinary; paronychium narrow, acute, and curved, hairy at base.

Vasiform orifice (Pl. II, fig. 11) transversely elliptical; operculum sub-rectangular, almost filling the orifice leaving the cylindrical rod-like, setose lingula exposed which projects about the length of the orifice caudad; supports at the base of the valves of the ovipositor lightly built and curved, prominent spines at the tip of the abdomen (Pl. II fig. 10).

Adult male (Pl. I, fig. 10). Length from vertex to apex of claspers about ·912 mm., in colour much the same as the female. Antennæ (Pl. II, fig. 14) of seven segments, shape and armature of the segments much the same as in the female, length second segment ·039 mm., III ·089 mm., IV ·023 mm., V ·027 mm., VI ·023 mm., VII ·035 mm.

Forewing (Pl. II, fig. 12) about ·68 mm. by ·26 mm.; hind wing about ·58 mm. by ·21 mm. concolorous with the female.

Hind tibia ·285 mm.; proximal tarsus ·095 mm., distal tarsus (Pl. II, fig. 13) ·057 mm.; claws ordinary.

Vasiform orifice as in the female, the lingula reaching the cephalic end of the claspers (Pl. II, fig. 9) which are ·082 mm. long, ·027 mm. broad at the shoulder, narrowing distally, the tips smooth, curved inwards, armed with numerous acicular spines on tubercles, inner margin with a small, membranous expansion near the distal end and with about four prominent spines. Penis slightly narrowed distally, shorter than the claspers.

Bemisia gossypiperda, n. sp., is allied closely to *Bemisia religiosa*, Peal, which the late Mr. Peal found on pipal (*Ficus religiosa*) and Banyan (*Ficus bengalensis*) in one locality only in Calcutta.

MGIPC—M—III-1-6—18-7 29—600.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE MANAGER, GOVERNMENT OF INDIA CENTRAL PUBLICATION BRANCH, IMPERIAL SECRETARIAT BUILDING, 3, GOVERNMENT PLACE, WEST, CALCUTTA;

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR;

AND

ALL AGENTS FOR SALE OF GOVERNMENT PUBLICATIONS.

A complete list of the publications of the Imperial Department of Agriculture in India can be obtained on application from the above-mentioned.

These publications are :—

1. The *Agricultural Journal of India.* A Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, farm implements, and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, and is issued once every two months or six times a year. *Annual subscription,* Rs. 6 or 9*s.* 6*d.* including postage. Single copy Re. 1-8 or 2*s.*
2. The *Journal of the Central Bureau for Animal Husbandry and Dairying in India.* A quarterly dealing with cattle-breeding, dairying, cultivation and storage of fodder crops, animal nutrition, and other aspects of animal husbandry. It is edited by the Agricultural Adviser to the Government of India. *Annual subscription,* Rs. 2-8. Single copy As. 10.
3. Scientific Reports of the Agricultural Research Institute, Pusa
4. Review of Agricultural Operations in India.
5. Proceedings of the Board of Agriculture in India.
6. Proceedings of Sectional Meetings of the Board of Agriculture.
7. Memoirs of the Imperial Department of Agriculture in India.
   - (*a*) Botanical Series.
   - (*b*) Chemical Series.
   - (*c*) Entomological Series.
   - (*d*) Bacteriological Series.
   - (*e*) Veterinary Series.
8. Bulletins issued by the Agricultural Research Institute, Pusa.
9. Books.

The following are the publications of the last two years :—

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, the Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1926-27. Price, Re. 1-14 or 3*s.* 3*d.*

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1927-28. Price, Rs. 2-6 or 4*s.* 3*d.*

Review of Agricultural Operations in India, 1925-26. Price, Rs. 2-6 or 4*s.* 3*d.*

Review of Agricultural Operations in India, 1926-27. Price, Rs. 2 or 3*s.* 6*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on 7th December, 1925, and following days (with appendices). Price, Re. 1-14 or 3*s.* 3*d.*

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

Botanical Series

Vol. XIV, No. IV. Studies in Gujarat Cottons, Part IV: Hybrids between Broach-deshi and Gogharí varieties of *Gossypium herbaceum*, by M. L. PATEL, M.Ag., and S. J. PATEL, B.Ag. **Price, As. 14 or 1s. 6d.**

Vol. XIV, No. V. The Indigenous Cotton Types of Burma, by T. D. STOCK, B.Sc., D.I.C., A.R.C.S. **Price, As. 9 or 10d.**

Vol. XIV, No. VI. A Study of *Fusaria* common to cotton plants and cotton soils in the Central Provinces, by JIWAN SINGH, M.Sc. **Price, As. 5 or 8d.**

Vol. XIV, No. VII. The *Kolamba* Rice of the North Konkan and its Improvement by Selection, by R. K. BHIDE and S. G. BHALERAO, B.Ag. Price, Re. 1-4 or **2s.**

Vol. XIV, No. VIII. *Pennisetum typhoideum*: Studies on the Bajri Crop. 1. The Morphology of *Pennisetum typhoideum*, by S. V. GODBOLE, M.Sc., B.Ag. **Price, As. 12 or 1s. 3d.**

Vol. XV, No. I. **Studies in Khandesh Cotton, Part I, by S. H. PRAYAG, M.Ag.** Price, Re. 1-4 or 2s. 3d.

Vol. XV, No. II. The Indian Types of *Lathyrus sativus* L. (Khesari, Lakh, Lang, Teora), by GABRIELLE L. C. HOWARD, M.A., and K. S. ABDUR RAHMAN KHAN. Price, Re. 1-8 or 2s. 6d.

Vol. XV, No. III. Fruit-Rot Disease of Cultivated Cucurbitaceæ caused by *Phythium aphanidermatum* (Eds.) Fitz., by M. MITRA, M.Sc., F.L.S., and L. S. SUBRAMANIAM, F.L.S. Price, As. 6 or 8d.

Vol. XV, No. IV. Colour Inheritance in Rice, by S. K. MITRA, M.S., Ph.D., and S. N. GUPTA and P. M. GANGULI. Price, As. 6 or 8d.

Vol. XV, No. V. *Asterina* spp. from India determined by DR. RUTH RYAN and *Meliola* spp. from India and one from Malay determined by Prof. F. L. STEVENS. Price, As. 4 or 5d.

Vol. XV, No. VI. Studies on Rice in Sind, Part I, by K. I. THADANI, M.Sc., and H. V. DURGA DUTTA, B.Sc. Price, Re. 1 or 1s. 9d.

Vol. XV, No. VII. Variability in certain economic characters particularly in seed weight and weight of lint per seed in pure strains of Broach Deshi Cotton, by MAGANLAL L. PATEL, M.Ag., and HAROLD H. MANN, D.Sc. Price, As. 14 or 1s. 6d.

Vol. XV, No. VIII. Studies in the Shedding of Mango Flowers and Fruits, Part I, by P. V. WAGLE, M.Ag. Price, As. 11 or 1s. 3d.

Vol. XVI, No. I. Studies in the *Jowars* of Gujarat; I. The *Jowars* of the Surat District, by M. L. PATEL, M.Ag., and G. B. PATEL, B.Ag. Price, Re. 1-6 or 2s. 3d.

Vol. XVI, No. II. Studies in Indian Chillies, I: The Types of Capsicum, by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and KHAN SAHIB ABDUR RAHMAN KHAN. Price, Re. 1-8 or 2s. 6d.

Vol. XVI, No. III. Foot-rot and wilt of Antirrhinums caused by *Phytophthora pini* var. *antirrhini* n.v., by S. SUNDARARAMAN, M.A., and T. S. RAMAKRISHNAN, M.A. Price, Re. 1 or 1s. 9d.

Vol. XVI, No. IV. Further studies of Indian Grasses and Grass-lands, by W. BURNS, D.Sc. (Edn.), L. B. KULKARNI, M.Ag. (Bom.), and S. R. GODBOLE, B.Sc. (Bom.). Price, Re. 1-4 or 2s. 3d.

Vol. XVI, No. V. Studies of Sugarcane roots at different stages of growth, by RAO BAHADUR T. S. VENKATRAMAN, B.A., and R. THOMAS. Price, As. 13 or 1s. 6d.

Vol. XVI, No. VI. Studies in Indian Pulses: 1. Lentil (*Ervum lens* Linn.), by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and RAKHAL DAS BOSE, B.Sc. Price, Re. 1-10 or 2s. 6d.

Vol. XVI, No. VII. *Pythium aphanidermatum* (Eds.) Fitz. on *Opuntia Dillenii*, Haw., by T. S. RAMAKRISHNA AYYAR, M.A. Price, As. 8 or 10d.

Vol. XVII, No. I. Non-dehiscence of anthers in Punjab American Cottons by TREVOR TROUGHT, M.A. Price, As. 4 or 5d.

Vol. XVII, No. II. Studies in the Wilt Disease of Cotton in the Bombay Karnatak, Series I, by G. S. KULKARNI, M.A., and B. B. MUNDKUR, M.A.; with an Introduction by HAROLD H. MANN, D.Sc. Price, As. 9 or 1s.

Vol. XVIII, No. I. The Calculation of Linkage values. A Comparison of Various Methods, by MAHBUB ALUM, M.Sc. Price, Re. 1 or 1s. 6d.

Chemical Series

Vol. IX, No. III. Some Digestibility Trials on Indian Feeding Stuffs, II, by P. E. LANDER, M.A., D.Sc., A.I.C., and PANDIT LAL CHAND DHARMANI, L.Ag., B.Sc. (Ag.). Price, As. 10 or 1s.

Vol. IX, No. IV. The Effect of Manuring a Crop on the Vegetative and Reproductive Capacity of the Seed, by B. VISWANATH, F.I.C., and M. SUBRAMANYAYANA, B.Sc. Price, As. 14 or 1s. 6d.

Vol. IX No. V. Experiments on the Feeding of Sorghum silage and concentrate to Scindi calver, by F. J. WARTH, M.Sc., and SHARI KANT SRA. Price, As. 9 or 10d.

Chemical Series—*contd.*

Vol. IX, No. VI. **Losses and gains of Nitrogen in an Indian Soil studied in relation to the seasonal composition of well waters, and the bearings of the results on the alleged deterioration of soil fertility,** by HAROLD E. ANNETT, D.Sc., F.I.C., M.S., B.Ag. Price, Rs. 2 or 3*s.* 6*d.*

Vol. IX, No. VII. **Some Digestibility Trials on Indian Feeding Stuffs,** Part III: Some Punjab Hays, by P. E. LANDER, M.A., D.Sc., A.I.C., and PANDIT LAL CHAND DHARMANI, L.Ag., B.Sc. (Ag.). Price, As. 5 or 6*d.*

Vol. IX, No. VIII. The determination of the Electrical Conductivity of the aqueous Extract of Soil as a rapid means of detecting its probable Fertility, by ASHUTOSH SEN, M.Sc. Price, As. 4 or 6*d.*

Vol. X, No. I. **Feeding Experiments at Karnal,** by F. J. WARTH, M.Sc., and F. J. GOSSIP. Price, As. 8 or 10*d.*

Vol. X, No. II. **Soils of the Punjab,** by DR. P. E. LANDER, M.A., D.Sc., A.I.C., DR. RAMJI NARAIN, D.Sc., and MEHTA MOKAND LAL, B.Sc., L.Ag. Price, Rs. 3-14 or 6*s.* 9*d.*

Vol. X, No. III. **Adulteration of Butter and Ghee with Animal Fat and Vegetable Ghee,** and its detection, by PHANIBHUSAN SANYAL, M.Sc. Price, As. 5 or 6*d.*

Entomological Series

Vol. X, Nos. I. & II. **Four New Indian Gall Midges,** by DR. E. P. FELT; The Citrus Psylla (*Diaphorina citri*, Kuw.), by M. AFZAL HUSAIN, M.Sc., M.A. Price, Re. 1-2 or 2*s.*

Vol. X, No. III. Braconidæ Vipioninæ of South India, by T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., F.Z.S. Price, As. 14 or 1*s.* 3*d.*

Vol. X, No. IV. Some New Indian Miridæ (*Capsidæ*), by E. BALLARD, B.A., F.E.S. Price, As. 6 or 8*d.*

Vol. X, No. V. **The use of Hydrocyanic Acid Gas for the Fumigation of American Cotton on import into India. Experiments on its lethal power for the Mexican Boll-weevil (*Anthonomus grandis*) and for the Grain-weevil (*Sitophilus oryzae*); on the extent to which it is absorbed by Cotton and Jute respectively; and on a practical method for satisfactory fumigation on a large scale,** by A. JAMES TURNER, M.A., B.Sc., and D. L. SEN, M.Sc. TECH., M.Sc., with a Foreword by B. C. BURT, M.B.E., B.Sc. Price, Rs. 2 or 3*s.* 9*d.*

Vol. X, No. VI. **Studies on *Platyedra gossypiella*,** Saunders (Pink bollworm), in the Punjab, by SOHAN SINGH BINDRA, M.Sc. Price, Re. 1-4 or 2*s.* 3*d.*

Vol. X, No. VII. A Contribution to our knowledge of the Thysanoptera of India, by T. V. RAMAKRISHNA AYYAR, Ph.D., F.E.S., F.Z.S. Price, Re. 1-9 or 2*s.* 6*d.*

Vol. XI. **A List of the Generic Names used for Microlepidoptera,** by T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S. Price, Rs. 3 or 5*s.* 3*d.*

Bacteriological Series

Vol. II, No. II. **A Bacterial Soft Rot of Garden Poppy,** by C. S. RAM AYYAR, B.A. Price, As. 5 or 6*d.*

Vol. II, No. III. **Nitrification of Calcium Cyanamide in some Indian Soils,** by J. H. WALTON, M.A., M.Sc. Price, As. 10 or 1*s.*

Veterinary Series

Vol. IV, No. I. The Chemotherapy of Surra (*Trypanosoma evansi* Infections) of Horses and Cattle in India, by J. T. EDWARDS, D.Sc., M.R.C.V.S. Price, Rs. 4-2 or 7*s.*

Vol. IV, No. II. Studies in Bovine Lymphangitis, by V. KRISHNAMURTI AYYAR. Price, Re. 1-2 or 2*s.*

Vol. IV, No. III. **Trypanblue and certain dithio-aniline derivatives: their efficacy in the treatment of Piroplasmosis and other affections in the Central Provinces,** by Major R. F. STIRLING, F.R.C.V.S., D.V.S.M., F.Z.S., I.V.S. Price, As. 3 or 4*d.*

Vol. IV, No. IV. Nasal Granuloma in Cattle in Bihar and Orissa, by RAI SAHIB P. N. DAS. Price, As. 3 or 4*d.*

Bulletins issued by the Agricultural Research Institute, Pusa

No. 166. Sampling for Rice Yield in Bihar and Orissa, by J. A. HUBBACK, I.C.S. Price, As. 7 or 9*d.*

No. 167. A Scheme of Classification of the Varieties of Rice Found in Burma, by R. A. BEALE. Price, As. 6 or 8*d.*

No. 168. List of Publications on Indian Entomology, 1926 (compiled by the Offg. Imperial Entomologist and the Imperial Entomologist). Price, As. 10 or 1*s.*

No. 169. The Stem-bleeding Disease of Arecanut (*Areca catechu*) caused by *Thielaviopsis paradoxa* Von Hon., by S. SUNDARARAMAN, M.A., C. KRISHNAN NAYAR and T. S. RAMAKRISHNAN, M.A. Price, As. 9 or 1*s.*

No. 170. Seasonal Variations in the Germ Content of Milk at Pusa, by J. H. WALTON, M.A., M.Sc. Price, As. 6 or 8*d.*

No. 171. The Improvement of Indian Wheat. A Brief Summary of the Investigations carried out at Pusa from 1905 to 1924, including an account of the new Pusa Hybrids, by ALBERT HOWARD, C.I.E., M.A., and GABRIELLE L. C. HOWARD, M.A. Price, As. 8 or 10*d.*

Bulletins issued by the Agricultural Research Institute, Pusa—*contd.*

No. 172. The Mechanical Analysis of Tropical Soils, by J. CHARLTON, M.Sc., F.I.C. Price, As. 3 or 4*d*.
No. 173. Occurrence of Trichomonad Flagellates in the blood stream of Fowls, by HUGH COOPER, M.R.C.V.S., and AMAR NATH GULATI, M.Sc. Price, As. 3 or 4*d*.
No. 174. Unit System for Farm Buildings, by G. S. HENDERSON, N.D.A., N.D.D. **Price, As. 5 or 6*d*.**
No. 175. A Comparative Study of the methods of preparation of the Soil for the Mechanical Analysis, with a Note on the Pipette Method, by AMAR NATH PURI, Ph.D., and B. M. AMIN, B.A. Price, As. 4 or 5*d*.
No. 176. A Method of increasing the Manurial Value of *Makua* Cake, by N. D. VYAS, L.Ag. **Price, As. 4 or 6*d*.**
No. 177. Root-rot and Sclerotial Diseases of Wheat, by L. S. SUBRAMANIUM, F.L.S. Price, As. 4 or 5*d*.
No. 178. A Study of the Locular Composition in Cambodia Cotton, by V. RAMANATHAN, L.Ag. Price, As. 7 or 9*d*.
No. 179. A Leaf Spot and Blight Disease of Onions, caused by *Alternaria palandui* nov. sp., by C. RANGASWAMI AYYANGAR. Price, As. 6 or 8*d*.
No. 180. Stem-rot of Berseem, caused by *Rhizoctonia Solani* Kühn, by MD. TASLIM. Price, As. 8 or 9*d*.
No. 181. Life History, Bionomics and Control of *Myllocerus maculosus*, Desb. (Curculionidæ; Coleoptera), by KIDAR NATH TRIHAN, M.Sc. Price, As. 14 or 1*s*. 6*d*.
No. 182. Investigations in the Bacteriology of Silage (1926-27), by J. H. WALTON, M.A., M.Sc. Price, As. 5 or 6*d*.
No. 183. A Milk Fermenting Yeast, by C. S. RAM AYYAR, B.A. Price, As. 5 or 6*d*.
No. 184. List of Publications on Indian Entomology, 1927. (Compiled by the Imperial Entomologist.) Price, As. 6 or 9*d*.
No. 185. The Cultivation of Lac in the plains of India, *Laccifera lacca*, Kerr., by C. S. MISRA, B.A. (Revised Edition.) Price, Rs. 4 or 6*s*. 9*d*.
No. 186. A Preliminary Note on the Rice crop in the United Provinces, by R. L. SETHI. Price, As. 7 or 9*d*.
No. 187. The Production of Cigarette Tobacco by Flue-Curing, by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and KASHI RAM. Price, Re. 1 or 1*s*. 9*d*.
No. 188. Designs for Farm Buildings, by G. S. HENDERSON, N.D.A., N.D.D. Price, As. 6 or 8*d*.
No. 189. The Improvement of Dharwar-American Cotton by Hybridization, by R. K. KULKARNI, B.Ag., and T. R. KHADILKAR, B.Ag. Price, Rs. 2-2 or 4*s*.
No. 190. Description of a New species, *Dipylidium catus* n. sp., with a Note on the Genus *Dipylidium* Leuckart, 1863, by AMAR NATH GULATI, M.Sc. Price, As. 6 or 8*d*.
No. 191. Agricultural Implements and Machinery at Pusa, Part I: Cultivation Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.Ag. Price, As. 12 or 1*s*. 3*d*.
No. 192. Agricultural Implements and Machinery at Pusa, Part II: Harvesting and Threshing Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.Ag. Price, As. 6 or 8*d*.
No. 193. Agricultural Implements and Machinery at Pusa, Part III: Special and Miscellaneous Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.Ag. Price, As. 9 or 1*s*.
No. 194. Agricultural Implements and Machinery at Pusa, Part IV: Power Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.Ag. Price, As. 12 or 1*s*. 3*d*.
No. 195. Some Diseases of Crops in the Andaman Islands by M. MITRA, M.Sc., F.L.S. Price As. 4 or 5*d*.
No. 196. The Cotton White-fly (*Bemisia gossypiperda*, n. sp.), by Rai Bahadur C. S. MISRA, B.A., and KARAM SINGH LAMBA, M.Sc. Price, As. 10 or 1*s*.

Books

Wheat in India, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S., and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 5 or 7*s*. 6*d*.
A Description of the Imperial Bacteriological Laboratory, MUKTESAR; Its Work and Products, by MAJOR J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, As. 8 or 9*d*. Hindi and Urdu Editions, Rs. 2-4 each.
Agriculture in India, by JAMES MACKENNA, M.A., I.C.S. Price, As. 4 or 5*d*.
Some Diseases of Cattle in India. A Handbook for Stock-owners. (Revised in 1927.) Price, Re. 1-4 or 2*s*.
Report on the Diseases of Silkworms in India, by A. PRINGLE JAMESON, D.Sc. Price, Rs. 3.
The Importance of Bacterial Action in Indigo Manufacture, by C. M. HUTCHINSON, B.A. Price, As. 2.

Notice

All new publications are included in the above list and are regularly posted to all on the mailing list as soon as issued. Unless complaints of non-receipt of any publication are received by the Manager, Government of India Central Publication Branch, Imperial Secretariat Building, 3, Government Place, West, Calcutta, within six months of the date of issue, duplicate copies can be supplied only on payment of cost and postage.

MGIPC—M—III-1-6—22-7-29—600.