

THE FIRST REPORT
OF
THE MERCHANTS'

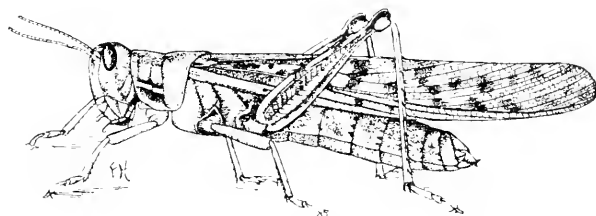
LOCUST INVESTIGATION COMMISSION

OF
BUENOS AIRES

BY

LAWRENCE BRUNER

Professor of Entomology and Ornithology
in the University of Nebraska, U. S. A.



PUBLISHED IN ENGLISH AND SPANISH
BY THE COMMISSION

BUENOS AIRES

SOUTH AMERICAN BANK NOTE Co. — CHILE 263, SAN MARTÍN 155

March, 1898

10.4963

22
2-5
1741-
18
30

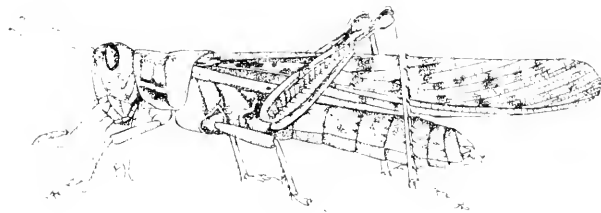
THE
FIRST REPORT
OF THE
MERCHANTS' LOCUST

INVESTIGATION COMMISSION
OF
BUENOS AIRES

BY

LAWRENCE BRUNER

Professor of Entomology and Ornithology in the University
of Nebraska, U. S. A.



PUBLISHED IN ENGLISH AND SPANISH
BY THE COMMISSION

BUENOS AIRES

SOUTH AMERICAN BANK NOTE CO., CHILE 263, SAN MARTIN 155

Mich. 1898

LOCUST INVESTIGATION COMMISSION

The continual ravages committed by the Locust in the Argentine Republic, and the extension of the area visited by them from year to year, drew increased attention to the subject of their study and destruction until a general movement was made to organize some system for saving the country from the terrible losses inflicted by the insect.

The commercial body, though so deeply interested, were unable to take an active part in any practical destruction, but gladly took up a proposal that they should help in the study of the insect so as to assist the Government in framing suitable laws, and the people in finding the most practical means for the destruction of the locusts.

An informal meeting was held, a circular issued, and an open meeting was called for the 18th January, 1897, when resolutions, as already published, were passed and the following gentlemen were named to act as a commission to carry them into effect: Messrs. R. Agar, Juan Drysdale, Wm. F. Mulhall, H. von Bernhardt, G. T. Crane, J. F. Roberts and Wm. Goodwin, together with Messrs. W. Bertram, C. H. Krabbé, José N. Drysdale, E. Horxthal, A. Devoto, E. Lernoud and A. G. Pruden, as suplentes. Subsequently Mr. R. Inglis Runciman joined the commission.

This commission, with Mr. J. F. Roberts as chairman and Mr. Wm. Goodwin as secretary, set to work at once, arranged for collecting subscriptions, obtained Minister Bermejo's approval of work proposed, opened correspondence with various quarters and took steps for engaging a professional entomologist.

The following gentlemen and firms subscribed towards the expenses and so far have been called on for 50 % of the sums promised:

J. & J. Drysdale & C. ^o	B. A. & Pacific Railway C. ^o
C. ^{ia} de Fabricantes Ingleses.	& Ensenada
La Agricultura.	& Rosario
Barclay, Mackintosh & C. ^o	& Western
Drabble Bros & C. ^o	Banco Francés del Rio de la
Ashworth & C. ^o	Plata.
Toso, Crane & C. ^o	Masurel fils.
C. H. Krabbé.	Henry Caulliez.
C. Pereda.	A. Descours.

Warden & C. ^o	J. Dussaud (P. & J. Dussaud)
Agar, Cross & C. ^o	S. Z. Danon.
T. Drysdale & C. ^o	Wattine. Bossut fils.
Moore & Tudor.	Sauberan & C. ^o
Hasenelever & C. ^o	Gmo. Séré & C. ^o
British Bank of S. A. L. ^d	Clarac frères.
The London y Brazilian Bank L. ^d	Runciman & C. ^o
The Anglo-Argentine Bank L. ^d	Gt. Southern Railway C. ^o L. ^d
Rabba, Richard & C. ^o	G. Kelsey & C. ^o
J. Shaw é hijos.	Calvet & C. ^o
Th. Bracht & C. ^o	Mc Gregor, Aitken & C. ^o
Arning, Brauss & C. ^o	Banco Alemán Transatlántico
E. A Bunge & J. Born.	P. Christophersen.
Baerwindt, Altgelt & C. ^o	W. Bertram.
H. Fuhrmann & C. ^o	The Argentine Colonization & Land C. ^o L. ^d
Engelbert, Hardt & C. ^o	Las Cabezas Estancia C. ^o L. ^d
C. F. Lahusen.	The London & R. P. Bank L. ^d
C. W. Fremery.	The Central Argentine Railway C. ^o
H. von Freeden.	The Cent. Córdoba Railway C. ^o
H. H. von Eicken.	The Argentine Gt. Western Railway C. ^o
Nord Deutscher Lloyd.	W. Goodwin.
Wiengreen & C. ^o	T. S. Boadle.
W. Samson & C. ^o	M. N. Díaz.
A. M. Delfino Hnos.	The River Plate Trust, Loan & Agency C. ^o L. ^d
W. Paats & C. ^o	C. Jewell.
O. Bemberg & C. ^o	C. Jewell (Las Petacas).
Duggan Hnos.	
Houlder Bros.	

Through the efficient and kind help of the Hon. W. J. Buchanan, Minister in the Argentine Republic of the United States, the services of Professor Lawrence Bruner, of the University of Nebraska, U. S. A., were obtained for the period of 12 months. This gentleman arrived in the country on the 1st. June, 1897, and in order to be back at his University within his leave has to sail from this country on the 27th inst.

The thanks of the Commission are also tendered to the innumerable correspondents who willingly collected valuable information for the Sub-Commission.

The Commission desires to thank very especially the Sub-commission presided over by Mr. Oliver C. James of Carcaraña for its valuable assistance throughout the entire investigation, as also the gentlemen whose names appear in the appendix of Professor Bruner's report.

The Commission has pleasure in endorsing the remarks of Professor Bruner in his report with respect to the hearty co-operation of the Railway Companies in granting free passes and supplying important details respecting flights of locusts, &c.

The Commission has now the pleasure to publish the accompanying report from Prof. Bruner which will convey to the

subscribers and public the results of his investigations, and it is thought that the work will be acknowledged to fully justify the steps and expenses incurred.

The National Government having carried into effect with great activity the law passed by Congress for the destruction of locusts, and having secured the services of professional entomologists, the commission's work is now drawing to a close; and it is hoped that the report herewith, of much value if only as regards the chapters on the fungus and hibernating habits of the locusts, may meet with the approval of the subscribers.

Buenos Aires, February 1898.

Letter of submittal.

Buenos Aires, February 7, 1898.

Sir:—

Herewith I beg to present a full but much condensed report covering my studies of the Destructive Locust of the Argentine Republic and surrounding regions of South America.

While the results that have been obtained are not what I should have desired, nor what were expected, they are very satisfactory indeed when we take into consideration the magnitude of the undertaking, the vastness of the country to be explored, the variety of topics to be considered, and the difficulty of obtaining reliable data on all of these varied subjects. It has been especially difficult to secure such facts from the outlying regions in the north and northwest where little or no population exists, but where such information would prove of the utmost importance in the settlement of certain points in our insect's life-history, — points that must be understood before anything in the way of reliable predictions concerning the possibility of invasion or non-invasion by "mangas" of the insect can be made.

Throughout the time that I have been in the country the various members of the "Commission" have always been very willing to aid me in every way they could. This they did at times even to the neglect of individual interests. The Sub-commission also was untiring in its efforts to obtain data which might be used in the settlement of various points relative to the life-history and habits of the insect in different parts of the Republic and surrounding portions of Uruguay, Brazil, Paraguay and Bolivia. Without these latter but little could have been accomplished.

I am sure that each member of the Commission will join personally in thanking the numerous correspondents throughout the country for their prompt replies to letters, and even circulars of inquiry, which it was found necessary to trouble them with from time to time. The various railway companies, too, deserve more than ordinary thanks for the willingness they

showed from the very beginning to do all in their power towards making the undertaking a success. Not only did they grant free passes for myself and assistants to any part of the country reached by their respective lines, but they also sent daily telegraphic reports concerning the movements of the various mangas so that we were enabled at all times to keep track of these as they passed over the country.

Trusting that the Commission will not be altogether disappointed with my services as indicated in the accompanying report, I am, your obedient servant,

LAWRENCE BRUNER.

Mr. J. F. Roberts, President.

INTRODUCTION

Although other insects very frequently commit an equal amount of damage to the crops and other vegetation of a country, they usually work much slower than do locusts. The former, besides working slowly, also do much of their injury during the night or while hidden from view; while the latter suddenly drop upon the region, as from the clouds, and in a day or two change the whole aspect of the country. In place of the beautiful panorama of green and gold, that existed only yesterday, we have before our eyes to-day a barren waste on which only the bare skeletons of the products of soil and labor remain to remind us of our losses. No wonder then that of all insect pests these locust-swarms are most dreaded by the human race.

Every country of any great extent of which the temperature is warm or hot, and a considerable portion of which is arid or semi-desert, or where the climate is liable to much variation, has its locust-swarms. If we read ancient history we find mention made of losses occasioned by these insects. They have occurred in times past and continue to appear at intervals in southern and eastern Europe; north and south Africa; west middle and southeastern Asia; south and middle Australia; the United States, Mexico, and Central America. Besides many of the islands adjoining these various countries are occasionally overrun by the pests. In nearly every one of these different regions the species of locusts concerned in the devastations are distinct from those found in the others. In Europe, Asia and Africa we find at least a dozen distinct kinds of these destructive locusts; while in Australia at least two or three others occur. Possibly North America is the most unfortunate of all countries in this respect, for fully two dozen distinct forms of

is common to parts of Europe, Asia and Africa, as one of the destructive locusts belonging to those countries.

While many of these locusts which belong to the genus *Schistocerca* are very similar in general appearance, and it is a rather difficult matter for an inexperienced person to separate the species as *voladoras*, or flyers, in the *saltona*, or hopper state, they differ so remarkably one from the other that they can quite readily be distinguished even by a novice in entomology. For example, the statement has been repeatedly made by writers of note that not only are the Argentine locust (*paranensis*) and the large North American species (*americana*) identical, but also that both of these and the oriental (*peregrina*) belong to one and the same species. An examination of the figures of both saltonas and voladoras as given herewith (colored plate) will at once settle this question. Even the insect which was described as *Acridium cancellatum* and which is likewise quite distinct, as the saltona would indicate, has been counted a synonym of the *peregrina*. There are also several other well marked forms of these large mottled locusts which are to be met with in various parts of tropical and semi-tropical regions of America and adjacent islands. No doubt an examination of their saltonas would likewise show them to be quite distinct from all of those named above.

The characters which separate the various species of *Schistocerca*, and which are more or less permanent in each, are such as the form and sculpture of prothorax; size of head; length and size of prosternal spine; comparative length and size of hind thighs and shanks; amount and arrangement of tegmina mottlings; comparative length of wings; and the general build of entire insect which may be either robust or fairly slender. By having large series of these insects from all over the earth before him the specialist would have no difficulty in making a synoptic table for their easy separation.

The various species of the genus to which our insect belongs are also more or less alike in their general habits. In many minor points, however, some of them differ quite materially one from the other—often to such an extent as to render it necessary to adopt special methods of warfare in dealing with each.

Without attempting to work out the full synonymy of *paranensis* at this time, or to enter more deeply into a discussion of

its classification and relationship to other destructive locusts of various parts of the world, the following pages will be devoted to giving an account of its life-history and habits. In doing this we must, of course, be more or less restricted to what has been ascertained from actual personal observations during the past eight or nine months. To this information, it is true, there must be added a great deal obtained from published accounts, as well as reports from numerous correspondents. This account of the insect's life-history and habits is of great importance, since upon this knowledge must be based the various recommendations for its subjugation and destruction.

CHAPTER II

Description.

The following description of *paranensis* in its various stages of growth and color-variations, together with the different illustrations that are given herewith, will enable the reader to

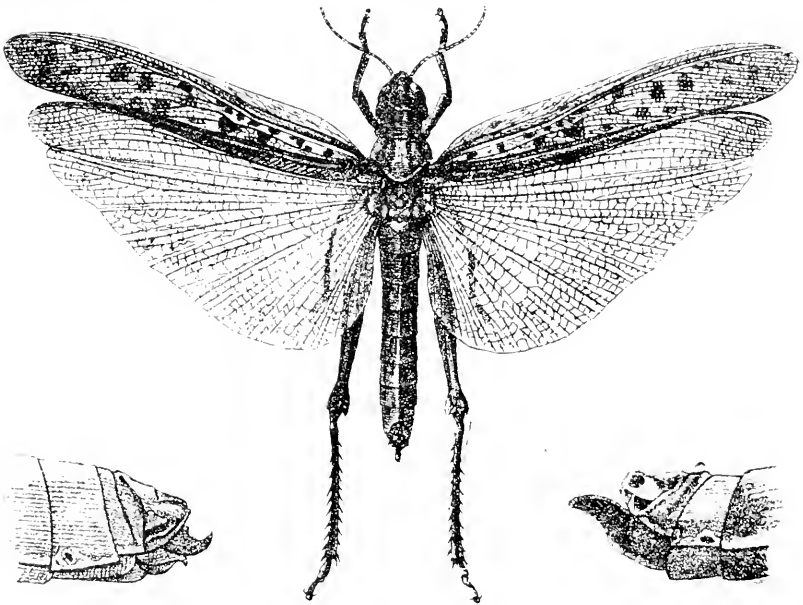


Fig. 2. — *Schistocerca paranensis*; male, with wings spread; tip of male abdomen, lower right hand corner; of female abdomen, lower left-hand corner. After Conil.

recognize our locust under almost any condition. The descriptions and drawings will also enable the reader to separate the Argentine locust from its near allies of both America and the Old World. The colored plate at the front of this report will show at a glance what the more detailed descriptions which follow confirm. It will show that our insect as a full-grown *saltona* is very decidedly marked, and that it is quite a pretty insect as compared with its near allies. Its deep black face and sides of prothorax will at once readily separate it from either *peregrina* or *americana* which have light-colored faces instead and but little black on the sides of thorax. It can also be distinguished from *americana* by its much larger head. The *ameri-*

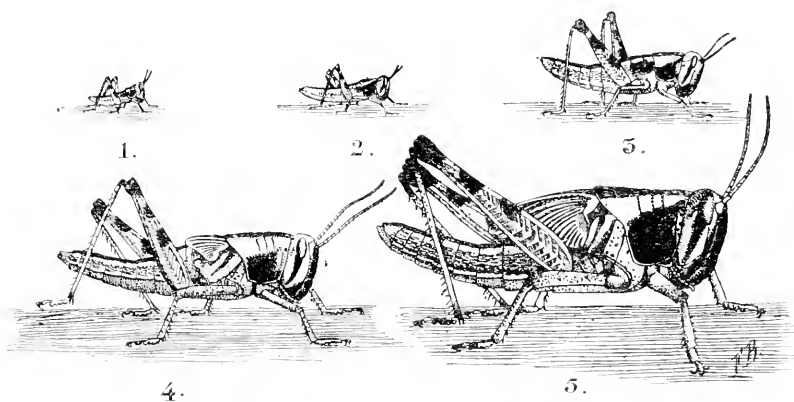


Fig. 3. — *Schistocerca paranensis*: various stages of *saltona*. From original drawing by F. Burmeister.

cana and *peregrina* can also be readily distinguished one from the other. First, by the small sized head of the former as compared with that of the latter; and secondly, by their respective colors. In *americana* the entire face, in fact the whole head with the exception of vertex and a line below each eye, is orange-yellow, while in *peregrina* the face above the upper lip only is yellow and the remainder of the head jet-black. Other variations in color are also to be found on thorax, legs, and body, that readily separate the two insects as *saltonas*.

Besides these color-variations there are structural differences, which, however, would be more noticeable to the

entomologist than to the general reader, hence they need not be mentioned here.

The following description of the saltona in its various stages may be of interest, since the reader may then be able to recognize the approximate ages of insects coming to his notice:

First stage.— There is no trace of wing-pads. The antennæ or feelers are thirteen-jointed, and have the eighth joint noticeably longer than any of the others. When first hatched, quite light in color and without any definite marking, but soon changing to a dull grayish-brown. Sides of prothorax and middle-thorax, ill-defined bands on hind legs, and stripe along the back much darker, almost black, in some specimens. Length from 7 to 9 millimeters.

Second stage.— There is still no indication of wing-pads present. The antennæ are now seventeen-jointed, and the third joint is slightly longer than any of the others. The general ground-color is somewhat lighter than it was during the first stage, being yellowish-gray, and the markings much better defined and clearer. The dark line along the back is well-defined and bordered on either side by a lighter one. The hind thighs are now clearly marked in middle above, midway between this and apex by a complete band, and have the apex black. Face in front black. Sides of abdomen marked with wavy lines of dark-brown and yellowish-gray, the dark color predominating. Length from 10 to 12 millimeters.

Third stage.— The wing-pads are now distinct though very small, and project obliquely downward and backward. The antennæ have from twenty to twenty-two joints. The body or ground color has become decidedly more yellow, while the face, sides of prothorax, and hind thigh bands are jet black. The other markings are reddish-brown. Length 18 to 20 millimeters.

Fourth stage.— The wing-pads are now of a considerable size and project obliquely upward and backward so that the tips of the hind pair almost reach the back edge of the following ring of the abdomen. The antennæ have twenty-four to twenty-five joints; and the colors are even brighter and more decided than in the preceding stage. The reddish-brown markings of the abdomen have changed to blackish-brown, while the eyes and top and back of head are tile-colored. Length from 26 to 30 millimeters.

Fifth stage.— The wing-pads are now quite large and, projecting backwards, their tips reach the back edge of the second

ring of the abdomen. Antennæ twenty-six jointed. Colors same as before. Length 35 to 40 millimeters.

A very few of the saltonas, about one in ten thousand, instead of being the usual shade, have the general ground-color greenish, and the dark markings very faint, though apparent. These greenish larvæ are consequently very conspicuous when seen among the others. They differ, though, very conspicuously from the green saltonas of *cancellata* which can be at once recognized by their lack of all dark mottlings save a number of minute black and white raised dots.

Sixth stage or Voladora. — This insect was described by Burmeister as follows :

It is most nearly allied to *A. rusticum* ⁶ Fabr. of North America, but is well distinguished from it by the much thicker head, plainly betraying its greater powers of mastication, and some variations in the markings .

While this description of Burmeister is rather inadequate, it suffices, since the type still exists in the Museo Nacional in Buenos Aires and has been examined and compared by the writer with specimens from various parts of the infested region. A more complete description is, however, herewith appended in order to aid future students to recognize the insect after the types may have been destroyed.

Length to tip of wings of average specimens, male, 62 millimeters, female, 70 millimeters ; of prothorax, male, 10 millimeters, female, 10.5 millimeters; of hind thighs, male, 23 millimeters, female, 27 millimeters.

Newly-winged specimens. — General ground-color of body above and of legs reddish-tile, streaked and dotted with darker and lighter markings as shown in the different illustrations presented herewith. Front wings, or tegmina, grayish-white mottled with dark-brown. Hind wings transparent, with the veins and cross-veins near base and hind border white; those towards and along front margin and apex dusky. Hind tibiae reddish, the spines white, tipped with black.

⁶ The *Acridium rusticum* of Fabricius may prove to be the same insect that was called *americanum* by Drury. Should such be the case, we can readily see the propriety of Burmeister's comparison. I understand that Samuel H. Scudder of Cambridge, Massachusetts, is at present engaged in studying the genus *Schistocerca* with a view to separating the species and of straightening out the synonymy. If such be a fact, entomologists will receive with delight his work when once completed and given to the world.



Fig. 1. — *Schistocerca paranensis*, photographed from life—slightly reduced in size.

Winter specimens.— As cold weather approaches in fall, the bright contrasts of color in our locust gradually disappear, and the insect takes on or assumes a dull-reddish tinge throughout. The brown bands on top and sides of prothorax and face become almost obliterated, and the white bands in middle of sides and on lower edge of pronotum entirely disappear. The hind wings change to a beautiful rose color which is quite decided on the basal half, and which gives the insect quite a different appearance while flying from that which it presented under like circumstances when it first became a voladora and for at least two months thereafter.

The colder and longer the winter the deeper appears to become the reddish tinge in the hibernating insects. Some few show a dull smoky-brown, while others become almost dirty black in their general color. In all, however, the wings are more or less vividly rose-colored.

Spring specimens.— In spring, when the insects forsake their winter-quarters and begin to feed upon the fresh vegetation and the time for mating approaches, the reddish hue of winter gradually gives way to a lighter shade. The rose color on the wings slowly disappears and in time is lost altogether. By the time egg-laying begins the insects have assumed a yellowish-olive hue where in winter they were red, and the wings instead of being rosy are yellowish hyaline.

When the wings are transparent the basal veins and cross-veins are white, as they change to rose-color the veins also assume that hue, and when they lose the rose-color and become hyaline the veins change to yellowish.

Thus we find that the same insect exhibits three distinct color-variations during its life as a voladora. Similar color-variations have been reported in the Old World *peregrina* as seen in different regions at times visited by it. But we do not recall any record of an attempt at an explanation for these variations in that insect. Similar, but less decided, variations in color have been observed by us in wintering locusts in North America. In fact, most of the brown or yellowish-brown locusts become more or less tinged with red late in fall after they have been several times exposed to frosts.

By observing the general color of the locusts making up an invading manga, it is possible, therefore, to tell whether they are young, middle-aged or old. None of the quite red specimens that were dissected by us here at headquarters contained fully

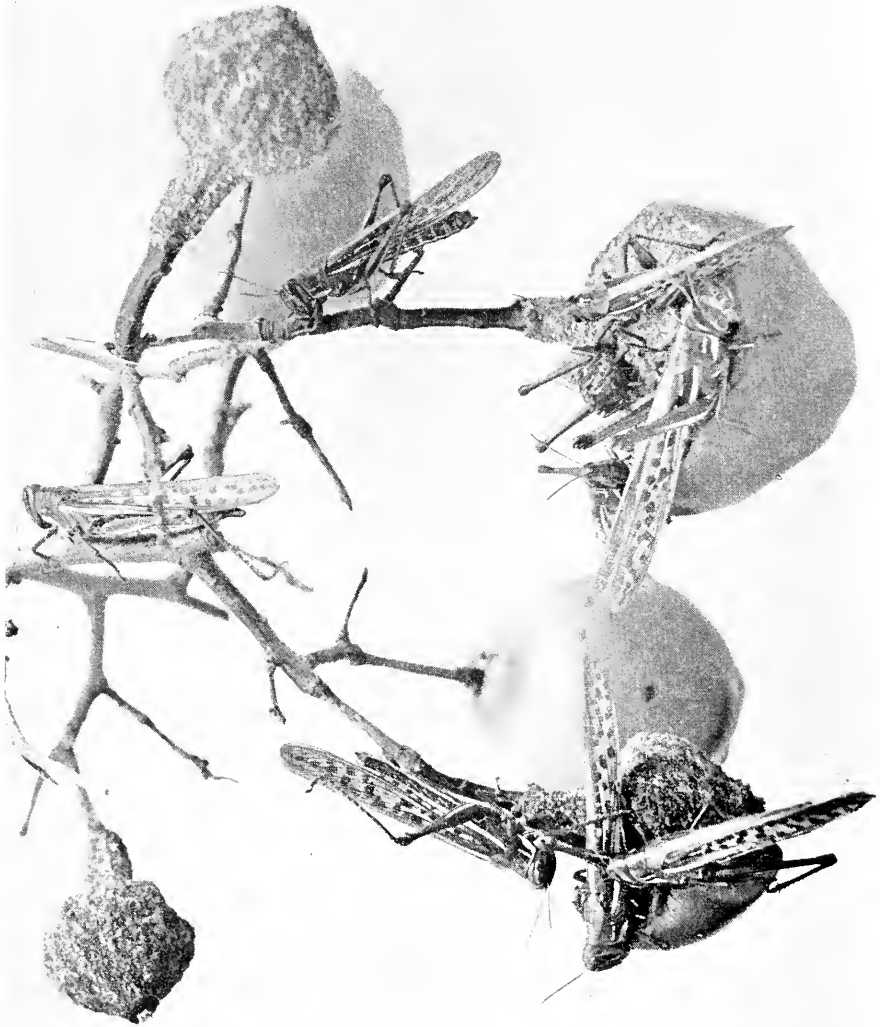


Fig. 1 1/2. — *Schistocerca paranensis*; group on fruit — 1/2 natural size. Original from photograph.

developed eggs, but some of the lighter colored ones showed them in an advanced stage of development.

In comparison with the Old World *Schistocerca peregrina* our locust is a little shorter and narrower-winged; has a slightly smaller head; a somewhat longer and less constricted prothorax; a trifle heavier and longer hind thighs; a longer, thicker, and more oblique prosternal spine. It is also quite distinct in color. The *peregrina* shows but little indications of dark and light lines or bands on prothorax and tegmina, while the mottlings on the latter are larger and much more evenly distributed over the whole wing.

From *americana* the *paranensis* differs less in color, but is more robust about the thorax and has a much larger head, a smoother and more constricted prothorax, a smaller prosternal spine, and shorter and lighter hind thighs. From *cancellata*, which is a rather larger insect than *americana*, it differs in as many respects as from the latter. The *cancellata* is, however, a rather lighter colored insect than either *americana* or *paranensis* though it is marked in a similar manner to both. There is also a greater difference in comparative size between the sexes than there is in those species. It is also apparently normal in its egg-laying and wintering habits; *i. e.* the eggs seem to be laid during late summer and fall, and hatch in spring at about the same time as those of *paranensis*. Hence it obtains its wings and mingles with the last named.

Egg-pod. — The hole or burrow which contains the egg-pod, or "cartucho", as it is called in this country, is from six to seven centimeters in length from top to bottom. Of this depth the eggs occupy a little more than one-half of the lower end. The entire burrow is a little curved, the lower end inclining towards the insect's head as she stands while constructing it and depositing her eggs. The diameter of this hole is approximately six and one-half millimeters for the upper two-fifths and nine millimeters at its widest part where the eggs are contained. There are normally from sixty to one hundred and twenty eggs in one of these cartuchos; and in their arrangement are quite regular as can be seen by a reference to the illustration (Fig. 6) which is ideal. In comparison with the eggs of the destructive locust of North America, *Melanoplus spretus*, those of *paranensis* are somewhat larger but more slender. They are not so regularly arranged, however, as we find them in *spretus*, but much more so than those of *americana* with which they agree in size and form.

During the operation of digging the hole and laying her eggs the insect's body is stretched to its utmost.

When the eggs have all been laid the female extrudes from its abdomen a frothy, more or less glutinous substance in sufficient quantity to fill the remainder of the hole. This substance on drying hardens to some extent and then resembles a very light pith. It is more or less impervious to water, and in a manner protects the eggs from the elements, while at the same time it affords an easy means of escape to the surface for the young saltonas when they hatch. In some locusts, and especially those that are native to countries with damp cold climates, this pithy material is quite abundant and very much more impervious to moisture than in such as are found in warmer and more arid regions. It is also more abundant in those forms which lay their eggs in fall rather than in the spring of the year.

CHAPTER III

Life-history. -- Habits.

Nearly, if not quite, every distinct species of animal or plant has a special life-history of its own which differs in some respects from that of all others. The life-history of *parvencensis* so far as known may be briefly stated as follows:

The *saltonas* hatch from eggs laid in the ground by the *colorados*. These *saltonas* molt or shed their skin six times and become full grown locusts. In due time these locusts go into winter quarters where they change their general color and remain till spring. They again stir about as the warm weather of this season increases, change color once more, mate, and lay eggs, thus completing the life cycle.

The eggs remain in the ground from twenty-five to sixty or seventy days before hatching. When hatching takes place the little nymphs or *saltonas* work their way to the surface through the pith-like substance that fills the hole between the eggs and the open air. On arriving at the surface they shed a skin or covering by which they have thus far been enveloped, rest a little while, then hop away and begin feeding. In four or five days another molt takes place, and at intervals thereafter four other sheddings of the skin occur. Under favorable conditions the *saltona* attains its growth in forty-five to fifty days; but unfavorable conditions, like cool, damp or very dry weather may extend the time a week or ten days. The shortest period between molts is that immediately after hatching and the shedding of the skin in which the insect leaves the egg-pod. This occurs in four or five days as stated above. After this,

under favorable conditions, the periods are about equal and range from eight to ten or eleven days.

After the insect has become full-grown and is provided with wings it is fully equipped for the migratory life which it leads. As will be seen by a reference to the portion of this chapter relating to "migration", the locust gradually works its way during the remaining summer and fall months to a favorable wintering place. During this time a gradual change in color is progressing. From the predominating grayish or reddish-brown and bright colours of the freshly winged individual it changes to reddish with obscure mottlings and rose-colored wings instead of the transparent ones possessed by it in the early part of its career as a flying locust. In this changed appearance it spends the winter with thousands of its companions in a more or less torpid condition tucked away from the cold among the grasses and thorny vegetation so characteristic of the "Chaco" country. All this time our insect has apparently thought of nothing but itself and of eating, for all our observations and the reports of correspondents and others would indicate that it does not begin to develop eggs before the following spring after it has come out of winter quarters. In early spring, when the nights begin to be warmer and fresh green grasses commence to appear, the reddish color of the insect gradually gives place to a yellowish olive and mating takes place for the first time fully seven months after it became a perfect insect and about ten days to two weeks before egg-laying begins. After this, mating may occur at any time up to death under favorable conditions. Eggs are laid chiefly during the months of September, October and November; though a few are deposited as early as August and as late as December.

The above seems to be the general rule in this insect's career from year to year. Other reports, however, mention egg-laying to have taken place in Mendoza, San Juan, Rioja, Catamarca, Salta, Jujuy and Santiago del Estero during the months of January, February and March. It is these seemingly abnormal features that make the whole matter one of doubt to the entomologist and that require more study to enable us definitely to settle whether the insect is not, after all, double brooded under certain conditions.

Another feature in the life-history of *Schistocerca paranensis*, that requires further study and additional data before we can be quite certain concerning the entire subject, is the number

of times an individual female may lay eggs before she dies a natural death. The general testimony seems to point to but a single *cartucho* of eggs; though some reports have claimed from three to five or even more layings for each female. The observations made and information gathered during the writer's sojourn in the country seem to point to the popular opinion. From among thousands of gravid females gathered all over the Republic and dissected for the purpose of trying to settle this moot-point, there were, however, at least three or four specimens found in which a secondary set of eggs showed quite plainly while the nearly mature ones were still in the insect's body. In these specimens there was apparently the full complement of eggs in each set, viz., about eighty or a hundred.

MOLTING.— Since large numbers of the locust die during the process of molting or shedding their skin, it seems worth while to briefly describe the process here. In doing this we can choose no better words than those employed by Professor Riley in describing the last molt of the Rocky Mountain Locust.

When about to acquire wings the pupa crawls up some post, weed, grass-stalk, or other object, and clutches such object securely with the hind feet which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennae drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing-pads, is noticed to swell. Presently the skin along this swollen portion splits right along the middle of the head and thorax, starting by a transverse, curved suture between the eyes, and ending at the base of the abdomen.

Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of Fig. 5, *a*. As soon as the skin is split, the soft white fore body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin, which, with its empty eyes, is worked back beneath, and the new feelers and legs are being drawn from their casings and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet imago—looks as in Fig. 5, *b*, the four front pupa legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that com-

mand over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor — of swelling and contracting — with an occasional brief respite, the antennae and the four front legs are freed, and the fullied and crimped wings extricated. The soft front legs rapidly stiffen, and, holding to its support as well as may be with these, the nascent locust employs whatever muscular force it is capable of to draw out the end of the abdomen and its long hind legs (Fig. 5, *c*). This



Fig. 5. — *Caloptenus spretus*; process of acquiring wings: *a*, pupa with skin just split on the back: *b*, the imago extending: *c*, the imago nearly out: *d*, the imago with wings expanded: *e*, the imago with all parts perfect, natural size. After Riley'.

in a few more minutes it finally does and with gait as unsteady as that of a new-dropped colt, it turns round and clambers up the side of the shrunken, cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength — the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are first rolled longitudinally to a point, and as they expand and unroll, the hind wings, which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (Fig. 5. *d*). From this point on, the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the

insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright (Fig. 5, *c*).

* * * * *

The molting, from the bursting of the pupa skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three-quarters of an hour, and sometimes but half an hour. It takes place most frequently during the warmer part of the morning, and within an hour after the wings are once in position the parts have become sufficiently dry and stiffened to enable the insect to move about with ease; and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not infrequently to the voracity of the more active individuals of its own species.

MIGRATING.—The Argentine locust, like its near allies in other portions of the world, is migratory in the true sense of the word. Other insects, like certain butterflies, moths, dragonflies, and winged ants, it is true, may and sometimes do gather in immense numbers and pass over the surface of the country to considerable distances. These flights, however, are not made in accordance with some set law or for a definite purpose in connection with the life-histories of the species making them. Neither are such flights of any great extent when compared with the distances covered by moving swarms of migratory locusts.

In writing on this topic, Professor C. V. Riley, who was the president of the United States Entomological Commission, says:—“In the Old World the migratory locust is known to fly for a distance of four or five hundred miles into central Europe from its permanent breeding-area in Asia. The flights taken by locusts in North America may extend over a distance of between one and two thousand miles, from their native breeding-places in Montana, for example, to Kansas and Missouri, and perhaps Texas.” What has been recorded concerning the distances traversed by locusts in their flights in the Old

* Rept. U. S. Ent. Com. Vol. I, p. 113, 1878.

World and in North America will apply equally well here in Argentina. Locusts here during their life as voladoras may fly to even greater distances than those recorded above.

Like as in North America, we can recognize several distinct movements in the swarms of *Schistocerca paranensis* as exhibited here in Argentina and the adjoining portions of Uruguay, Paraguay, Brazil, Bolivia and Chile. These may be designated as "Invading swarms", "Local swarms", and "Returning swarms"; although we have, as yet, not succeeded in definitely locating a "permanent breeding place" for this insect.

By *Invading swarms* we mean those swarms that come from a point to the northward of the settled districts of Santa Fé, Córdoba, Entre Ríos, etc., in the spring of the year. These invading swarms are usually composed of insects that have wintered as voladoras in the "Chaco" as is the almost general belief here in Argentina. They are, as a rule, of the dark or reddish form. This, as shown on a preceding page, indicates that they are *old* locusts which have wintered over. Invading swarms move towards the south, east, west, and north, according to the region over which they pass. It is the locusts of these swarms which deposit the eggs that later produce the myriads of saltonas in invaded districts.

The term *Local swarms* may be applied to the small mangas or swarms that drift about irregularly with the wind both in the "wintering" and "temporary or invaded" districts. Such swarms are most common just before the general movements commence in late summer, fall and spring. They may also be observed occasionally during pleasant days in winter. These flights seem to result from restlessness and a desire for new food rather than for breeding purposes or securing proper hibernating conditions. These local flights never last more than an hour or two, nor cover more than a score or so of miles of territory; and they are just as liable as not to return on the following day to the point from which they originally started.

The *Returning swarms* are made up of young insects that are very likely in search of the proper locations in which to pass the approaching winter months. They are the progeny of the invading swarms; and, as a rule, move towards the general direction from which their parents came. This general movement is, of course, more or less deviated from in different parts

of the country since the direction taken by moving mangas is more or less regulated by prevailing winds, surface configuration, temperature, humidity, and food-supply. In some parts of the country these general movements, and the courses taken by the insects concerned in them, are very well defined. In others our information is still so meager that nothing definite can be stated with regards to such movements even if they occur.

Apparently the locusts which start from the "central" wintering grounds early in August move southward and begin developing eggs a little later. Some of them maturing earlier than others, the females thus encumbered must necessarily drop down and remain behind to deposit their quota. Others with the eggs less advanced move on and in turn also ripen and deposit them; while still others go much further into the settled districts before egg-laying is forced upon them. In this manner, with favoring wind and weather, in a month or two, locusts that have wintered along the Río Salado in northern Santa-Fé, may reach even the Río Colorado, or beyond, as was shown the past spring. By the process of dropping out as their eggs had developed the entire route became stocked with eggs and later with the saltonas.

When these latter have acquired wings a northward movement begins; but instead of passing back over exactly the same route followed by the outcoming insects, the return flight is made first to the west, northwest, then north, and finally northeast—these directions being apparently regulated by prevailing winds, surface configuration, temperature, etc., as mentioned above. In other words, there is a sort of circular movement to be noticed if we combine the directions taken by the invading and returning mangas.

Whether or not the progeny of these insects which move away from this central wintering region to the northeast and north, following up the Parana and Paraguay rivers, succeed in returning to this locality cannot be definitely determined from the very meager data at hand. But that these directions are less frequently taken by insects leaving the winter quarters is quite evident from the numerous statements of correspondents to the effect that the regions under consideration are less often visited by invading swarms.

It is impossible also for similar reasons to make any definite statement concerning these invading and returning mangas in

the extreme northwest of the Republic and in Bolivia. Our information, however, seems to indicate that there are more outgoing than incoming mangas. Until these points can be definitely settled, there will remain a doubt as to the existence of a much further north breeding center and source of supply. It is a point that should be settled, if only to remove the doubts that at present exist.

What height above the surface these swarms may be capable of reaching we cannot say; but that at times they attain an altitude of five hundred or more meters there can be no doubt. Conil mentions a swarm near Cordoba in 1873 that reached an altitude of about two thousand meters. This was, perhaps, an exceptional case. Our observations indicate a much lower altitude, perhaps not more than one hundred to one hundred and fifty meters as the average at which invading swarms fly. At night the insects probably fly somewhat higher than during daytime. According to these figures, then, *paranensis* is a comparatively low flying insect, although in mountain regions they reach altitudes several thousand meters above sea-level as indicated by the fact of their having crossed the Cordilleras into Chile. During recent years this invasion of trans-Andine territory has occurred twice to my knowledge; viz., in 1891, and again the past year. Several reports have also been sent to headquarters during the past month of large quantities of the dead voladoras being seen among the snowdrifts near the summits of the Andes, where it is surmised that they must have perished from the cold while trying to cross the range.

The rate at which these insects travel varies greatly according to circumstances. Perhaps it frequently happens that they do not make more than three or four miles per hour when flying against unfavorable winds, or when there is little or none. At other times with brisk and favorable winds even fifteen to twenty miles an hour may be traversed. Allowing from three to six or even eight hours per day for flight at these slow rates considerable distances may be covered in six weeks or two months by a moving swarm.

The flights of *paranensis* are chiefly made during daytime in spring, early summer and late fall. In midsummer and early fall when the weather becomes hotter the insects are disposed to remain quiet during the middle or warmer portion of the day. Then towards evening they begin to fly about and shortly before sundown begin their regular migrations. On

pleasant, moonlight nights in summer when the winds are favorable their flights are continued long after nightfall. Not unfrequently have cases been mentioned by observers of their flying after ten o'clock at night. These night flights seem to be very much more frequent during dry seasons than in wet ones; and in arid than humid regions. In fact day flights seem to be rather the exception than the rule where the atmosphere is normally very dry. On the contrary, where the opposite is the case the insects choose daylight by which to make their journeys.

In taking a particular course it is not absolutely necessary to have the wind direct. The locust equally often flies quartering with the wind, and sometimes nearly at right angles with it. In spring the insects can and do move southward with any wind that is north of east or west. On the return flights any wind coming from south of these points of the compass will aid it onward. Only "head" winds, then, interfere with the migrations of our locust; and in many cases even these are made use of by slightly changing the course of flight. Very high winds, whether blowing in the right direction or not, cause the insects to drop to the ground. Storms also have the same effect upon moving mangas.

EGG-LAYING. — The eggs of our locust are laid chiefly in the spring of the year by insects that have been full-grown for at least eight or nine months and that have passed the previous fall and winter as voladoras. In this respect it resembles the large and closely allied North American *Schistocerca americana* which possesses a like habit. It will be noticed, however, that a reference is made on a preceding page to eggs being also laid during the months of January, February and March in some portions of the Republic. Our knowledge of the movements and habits of the insect in those particular regions is so limited that it is impossible to state definitely whether there might not be a second brood in the north, or whether these northern swarms are only another race in which egg-laying occurs a few months later than in the more southerly and less elevated regions.

The female locusts when ready to deposit their eggs usually gather in large numbers at suitable places. They are invariably accompanied by the males which may remain in copulation with them to within a few moments of the commencement of the burrow by the female.

In writing about egg-laying, in connection with the Rocky Mountain Locust, Professor Riley says: "The eggs may be laid in almost any kind of soil, but by preference they are laid in bare, sandy places, especially on high, dry ground, which is tolerably compact and not loose. It is often stated that they are not laid in meadows and pastures, and that hard road tracks are preferred; in truth, however, meadows and pastures, where the grass is closely grazed, are much used for ovipositing by the female, while on well-traveled roads she seldom gets time to fulfill the act without being disturbed. Thus a well-traveled road may present the appearance of being perfectly honeycombed with holes, when an examination will show that most of them are unfinished and contain no eggs; whereas a field covered with grass stubble may show no signs of such holes and yet abound with eggs." What is said above concerning the smaller Rocky Mountain Locust and its egg-laying habits, will fit equally well the much larger Argentine Locust as it normally carries out this mission in its life.

During the past season, however, the climatic conditions, coupled with the general health of the locusts, caused a variation in these insects' egg-laying habits in some portions of the country. Instead of confining their attentions to the more compact soils of road-sides, pastures and more or less bare camp, the females congregated in wheat-fields and other localities where the soil was rather loose. Here they left their eggs in countless millions. The reasons for this variance being possibly due to the excessive drought that prevailed at the time combined with the fact that a sort of disease in the insects' ovipositors prevented their digging to a great extent. In some localities the eggs were even extruded without the slightest attempt on the part of the females to bury them beneath the surface. Even during the nights, as the insects roosted upon trees and fence-posts, the eggs were laid. Sometimes in the morning the ground beneath was strewn with the dropped eggs and the glutinous frothy covering that had been also evacuated from the body as if a natural deposit had been made.

After having selected a suitable place for her eggs the female locust forces a hole in the ground by means of two pairs of horny valves which open and shut at the tip of her abdomen. Again quoting from Professor Riley in his report on the North American migratory locust, we have the following words: « With the valves closed she pushes the tips into the ground,

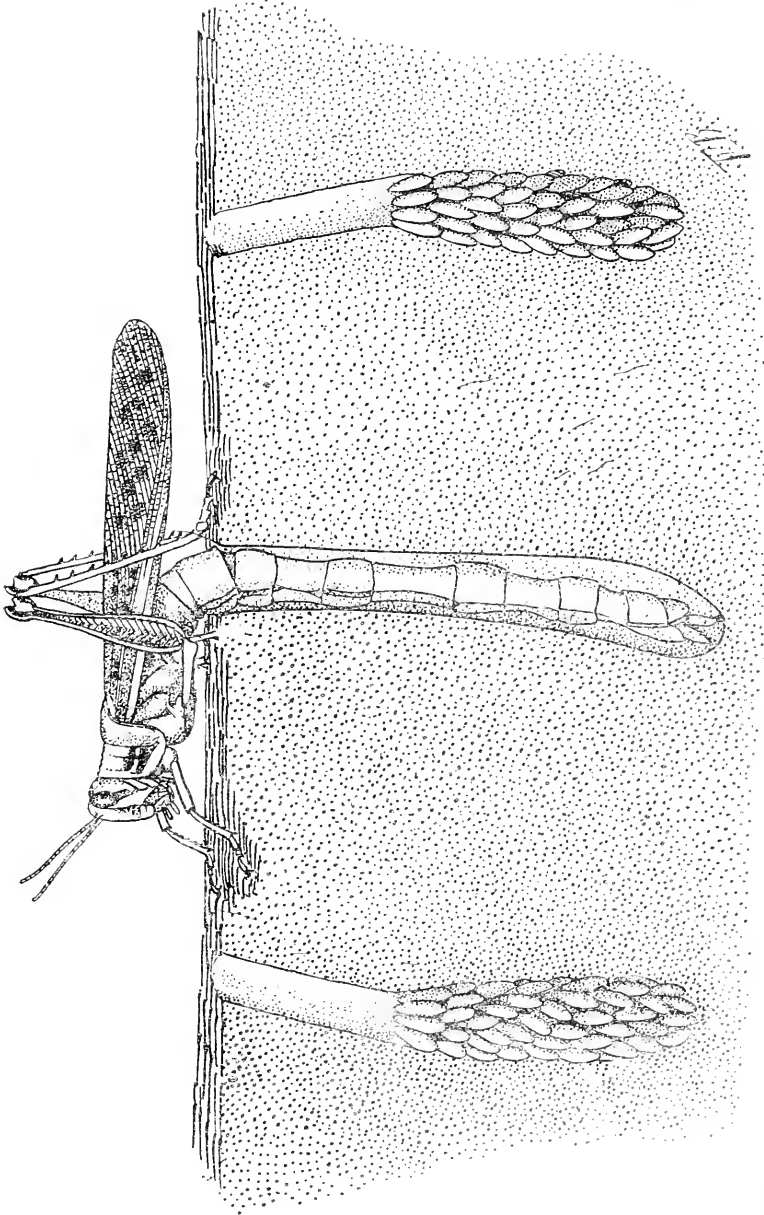


Fig. 6. — *b*. Female *Schistocerca paranensis* laying eggs; *a*, *c*, egg-curtachos. (From original drawings by F. Burmeister.)

and by a series of muscular efforts and the continued opening and shutting of the valves she drills a hole, until in a few minutes (the time varying with the nature of the soil) nearly the whole abdomen is buried. The abdomen stretches to its utmost for this purpose, especially at the middle, and the hole is generally a little curved, and always more or less oblique (See Fig. 6). Now, with hind legs hoisted straight above the back, and the shanks hugging more or less closely the wings, she commences ovipositing."

After the hole has been completed (Fig. 6) it is lined with a mucous matter which is extruded before egg-laying begins. This lining acts as a sort of protection to the eggs, and at the same time assists in keeping them together in a more or less compact mass. The eggs are then extruded one by one until all are laid; and as this progresses are arranged in the cluster more or less regularly as can be seen by again referring to the illustration numbered 6. After this has been completed the remainder of the hole is filled with "a compact and cellulose mass of the same material" as that previously used for lining the inside of burrow and cementing the eggs together. Though light and easily penetrated by insect enemies, this material is partly impervious to water, and therefore forms a more or less thorough protection for the eggs as before stated. It is much more abundant in some species of locusts than it is in others.

The egg-pod, or "cartucho" as it is called here in Argentina, is normally composed of from seventy to one hundred and twenty eggs, which statement has also been previously made. These latter are all arranged so that the little saltonas (mosquitos) upon hatching can each immediately work its way to the surface through the pith-like plug which fills the upper and slightly narrower neck of the hole without disturbing the others.

WINTERING. — As already hinted at on a preceding page, the *Schistocerca paranensis* passes the winter as an adult insect. In this respect it differs quite materially in its life-history from nearly all other locusts which are native to the country. Why, or how, this habit has been acquired by it need not be discussed at this time. That such is the fact is sufficient to know in dealing with it from the economic standpoint.

The region most frequented by this insect during winter seems to be that bordering the Rio Salado in Southeastern

Santiago del Estero, northeastern Córdoba and northern Santa Fé, and not the "*Chaco*", as we might be led to believe from the many published statements to that effect. According to the reports of correspondents and personal observations there are also a few other localities where the insect has been known to winter in smaller numbers. These seem to be confined to the provinces of Catamarca, Tucuman and Entre Rios. All of these latter points, however, as well as the former lie between the latitudes of 28° and 32° south, while the principal district seems to be along the 30th parallel and at a comparatively low altitude above sea-level. As the Andes are approached and a higher altitude attained an approach is made to the equator so as to maintain about the same temperature and other climatic conditions that appear to be more or less necessary for the welfare of the hibernating insects. A locality much further south would be too cold, while a nearer approach to the equator, unless at a considerable altitude, would be too warm.

In its winter quarters this insect gathers in immense quantities. Here it crawls in among the underbrush and grasses and piles up to such an extent that "heaps" of locusts can be found a foot or more high. These piles of the acridian are usually formed about some bush or clump of vegetation as a nucleus. During cold weather and at night they do not move but cling closely to all kinds of vegetation and to each other as most of us have seen them do in invaded districts during a pampero or a very cold night. When the sun shines brightly and there is little or no wind they move about to some extent and even eat a little. The rule, though, during winter seems to be that comparatively little food of any kind is taken by them. On opening hundreds of individuals during the months of July and August for the purpose of watching for the development of eggs it was invariably the case that they were found quite empty.

While in these wintering places the insects are pretty well protected from many of their natural enemies. Especially is this true with respect to insect-enemies, which, like themselves, at this time of year are also hibernating. Birds and some of the smaller and larger mammals can and do get at them and destroy comparatively large numbers. The "Gavilan" or large hawk which does so much good by following the various mangas over the country also accompanies them to their winter-quarters. Only that a large portion of these wintering

grounds are so far from water, as well as in quite dry regions many other birds would congregate about and feed on them throughout winter as they do in spring and summer.

No doubt by watching for the proper opportunities, large numbers of the insects could be destroyed by man during the hibernating season. Fires might be utilized for this purpose as was shown during the past winter in the vicinity of Ceres and Monogotes. Other methods that will be described in a subsequent chapter might also prove valuable at this time of year.

FOOD-HABITS. — This is a rather difficult subject to write on, since our locust seems to be capable of adapting its tastes to an exceedingly long list of food-plants. In fact, if one were inclined to name *all* of its food-plants and also those which it will not eat, the latter list would be by far the smaller of the two lists. Still when this habit of our acridian is compared with that of the *Melanoplus spretus* of North America, we can console ourselves by the thought that after all our insect is quite fastidious in its tastes.

The first paragraph under the heading of "Food-plants," in the First Report of the United States Entomological Commission reads as follows:

"The Rocky Mountain Locust may be said to be almost omnivorous. Scarcely anything comes amiss to the ravenous hosts when famished. They will feed upon the dry bark of trees or the dry lint of seasoned fence-planks; and upon dry leaves, paper, cotton and woolen fabrics. They have been seen literally covering the backs of sheep, eating the wool; and whenever one of their own kind is weak or disabled from whatsoever cause, they go for him or her with cannibalistic ferocity, and soon finish the struggling and kicking unfortunate. They do not refuse even dead animals, but have been seen feasting on dead bats and birds. Few things, therefore, come amiss to them. Yet where food is abundant they are fastidious and much prefer acid, bitter, or peppery food to that which is sweet".

In unsettled districts this Argentine locust is inclined to attack the leaves of trees, shrubs, herbs and most of the grasses; but among these a few kinds remain untouched by it. Of cultivated plants even fewer escape its attacks, but many are eaten only sparingly so long as there is plenty of other food to be had. All grains and most grasses suffer first, after which follow other forage plants.



Fig. 7. — Quanta showing vegetation to have visited by flying locusts. — Orig. mat.

Among shade trees the Paraiso and eucalyptus suffer little or no defoliation. In fact the former seems to be poisonous to them. If they eat of the leaves during the night they may usually be found lying dead on the ground in the morning. Broom-corn, kaffir-corn and sorghum are but partially injured, and then only by the voladoras as they chance to be resting on these plants during the day or night. Melons, — water and nutmeg, as well as cantaloupe and musk — are not liked by them. In fact none of the cucurbs seem to be favorite food-plants of theirs. Even the wild (gourd-like) pumpkin of the pampas is ignored by them. It is also quite noticeable that a great many of the native weeds are untouched in their almost general attacks upon the balance of the vegetation in any region. The milk-weeds appear to be especially exempt, as is also the plant known here as "Romarillo" or "mio-mio", and which is said to kill sheep and cattle if eaten by them. Others of the weeds are, however, chief among the plants eaten by the locusts. No order or even family of plants seems to be entirely exempt, for some forms of each are chosen by the pest as suitable for food.

After the grains and more tender and sweeter of the grasses come the leaves of such trees as the locust, willow, poplar, peach, plum, pear, the various acacias and most other thorny kinds, which latter classification would include about all the native forms. Garden plants, too, suffer to some extent, but are not so greedily eaten by this insect as by some of the other locusts of the country that are known as "tucuras". The sweet potato and yams seem to be exempt, while the tomato and ordinary potato are not great favorites of theirs.

A reference to figures 7 and 8, which are of the same quinta in the immediate vicinity of Bahia Blanca, will give the reader some idea of our locusts' tastes. These photographs were taken only a few days apart and from exactly the same spot. In the meanwhile the voladora locusts had been there to feed.

HABITS OF SALTONA. — The saltonas, or "mosquitos" as they are generally called when first hatched, have the habit of gathering in bunches on the bare ground, about the bases of various plants, or even creeping up the latter in such numbers as to completely cover them. This latter habit is commoner during cool, cloudy weather and late in the afternoon when preparing for spending the night. Where it is at all possible for them to do so they invariably "roost" at night above the ground.



Fig. 8. Photograph of heat-sterilized parasites shown in figure 7 taken 1 or 5 days later, after having been visited by flying locusts. Original.

So persistent are these quite small saltonas in bunching during the first four or five days of their life that but little time appears to be spent by them in feeding. Even up to and after the change to the second stage they remain so compactly together that they are more frequently seen "piled up" than scattered about. In fact the second shedding of the skin takes place while the insects are thus huddled together. Should they happen to take a notion to change their situation during this first week of their life they go "*en masse*" and do not march in open file as they do in later life.

This clustering seems to be of benefit to the insects since the necessary moisture that is required at the time of molting, as well as during their very small size, is thus more readily retained. In fact where these insects hatch in small numbers and on comparatively bare ground they soon shrivel up and die for lack of the necessary moisture. Especially is this the case when the weather is hot and dry, or in arid regions.

While this bunching in early life may be an inherited instinct, it serves the purpose of keeping the small saltonas alive where other species not possessing the same habit would perish for lack of the necessary moisture. It is this habit very likely that greatly aids in the increase of *paramensis* where other forms of locusts remain normal in number.

After they have transformed to the second larval or saltona stage, and have become sufficiently hardened to withstand greater hardships, these small locusts begin to move about a little more freely. Each one now seems more inclined to shift for itself than it did before. Still, even now the ranks are kept pretty close, and at night the bunching is resumed. In this second larval stage the insects also occasionally die of heat and drought, but very seldom if ever later. When the skin is again shed and the third stage is reached our locust really begins life as if he meant to grow up. Feeding begins in earnest and foraging expeditions are made in company with others as ambitious as himself. During the fourth and fifth stages, however, is the time when the true migratory instinct is developed and our insect exhibits its marching qualities. It is at this stage of its existence that the greatest amount of damage is done.

The saltona of *paramensis* is more of a walker than a jumper. At no time is it capable of jumping much over six or seven inches high, and much oftener scarcely reaches an altitude of

more than three or four inches above the ground when jumping. In this respect it differs greatly from our North American destructive locust and the majority of native grasshoppers both here and there. These latter very frequently spring several feet into the air. In fact our locust is not built for jumping, as an examination of its comparatively small and slender hind legs will show. Like the Wandering Locust of the Old World, the Argentine destructive locust is not particularly noted as a jumper; but when it comes to flying they are "right at home." On account of its non-jumping proclivities it has been necessary in the selection of remedies to discard several of the very best methods of destroying other larval locusts. Still, on account of its tendency towards bunching at all times it is one of the easiest of all locusts to fight. All that is required is the adoption of remedies that will conform to its habits, and then go to work and keep at it.

When marching the saltonas are like sheep. Where one or more lead all try to follow; and when once a manga gets to moving in a certain direction it is no easy matter to change its course. This trait in the insect renders it a comparatively easy one to trap in boxes, pits and ditches. Then too, their claws on the middle and front feet are short and weak so they cannot take hold of hard and smooth surfaces. This also renders their capture more easy since when once taken they can neither crawl nor jump out.

In their food-habits the saltonas differ but little from what has already been said regarding the voladoras. Only a few plants that are not molested by them are later attacked by the winged insects. It has also been observed that a few plants which are passed by when the insects are quite small are attacked by them when they are older and larger. It is also a fact that the insects feed on some plants which are young and tender, but not when older and tough, and vice-versa.

As with the voladoras, the saltonas seem quite panic-stricken under certain conditions. The approach of a *pampero* or other storm causes them to crawl under the grass, weeds, and other vegetation, where they hang fast as if in despair of their lives. When being driven, too, they often exhibit the same kind of fear and hide in like manner. But this latter only occurs when they are rushed and become confused. It also sometimes happens that where a field has been gone over day after day with the Carcaraña and other machines for capturing the in-

sects. they suddenly drop to the ground at its approach and cling there as described above.

Whether or not the saltonas have any definite instinct as to directions and choose these when marching, the writer has been unable to decide to his satisfaction. Mangas in the same region have been observed moving in various directions. There did not even appear to be a prevailing one, so varied were they. As soon, however, as the insects had become winged and begun flying their sense of direction showed itself by their invariably working toward the northwest.

CHAPTER IV

Reasons for the excessive increase of destructive locusts

Various causes may combine to permit of an insect's increasing beyond the normal. First of all climatic conditions have to be considered here. These have a great deal to do in the way of favoring or killing off the more or less delicately constructed natural enemies of the hardy species which comprise our most injurious forms. Diseases too, are controlled by climate; and these latter form an important item in the existence of most insect forms.

During a succession of abnormally dry years most locusts, whether "native" or "migratory", are permitted to increase beyond their ordinary numbers. Many of the parasitic insects and other animal-forms which flourish during wet seasons die off when the weather becomes dry. By this means several checking influences are removed and the locusts and other insect-pests are permitted to increase untrammelled.

The excessive increase above normal and non-injurious numbers in the present species can, without doubt, be attributed first, to its migratory habit coupled with that of bunching at all times. To these must be added its wintering as a perfect insect in localities selected by itself as guided by an instinct that has been developed after years of a nomad life. The climatic conditions, too, of the regions most frequented by it during the greater part of the year are very favorable to so hardy an insect as is our locust.

By its migratory habits and great powers of flight *paramen-*

s/s, like all other locusts possessing like habits, is able to choose at all times the most favorable breeding grounds, the richest pastures and the most pleasant weather, each and all of which features are very favorable to its increase and afterwards to its existence in unusually large numbers. In addition to the above favoring conditions, there may be still others that add to its multiplication, and that favor it beyond its congeners. Only further studies can decide these points for us.

By bunching at all times the insect escapes many natural enemies that it would surely come into contact with were it to scatter over the whole landscape. When young, as shown on a preceding page, this bunching prevents the insects from dying for lack of moisture at the time of molting. There is also less in-breeding under these conditions than there would be in a normal non-migratory life, which also means the better preservation of strength.

CLIMATIC INFLUENCES. — This is a subject concerning which we know comparatively little in connection with the life of our locust. Of course there are a few facts that have come to light, and which may be recorded here.

In the first place it is safe to assume that it is probably due to certain climatic conditions in connection with the peculiar life-habits of the locust that it has been permitted to increase beyond the norma. But just what these climatic influences are and have been seem, as yet, unsettled ideas.

The eggs of all insects require more or less moisture and heat for their preservation and final hatching. Some kinds require more and others less of both these elements. That the locust's eggs are also affected one way or the other by the presence or absence of heat and moisture in varying degree cannot be gainsaid. Just what each variation in these elements means in the final development of the insect under different circumstances, our individual researches and the study of results as reported by others have not revealed.

It is known that where the eggs are deposited in very dry soil and rains fail to fall they either dry up and are lost altogether, or they are retarded in hatching. Sometimes when there is just sufficient moisture present to prevent their drying up, but not sufficient to cause them to swell as they should, they may be retarded a month or more. On the contrary, if there be too much moisture the eggs are likewise kept from hatching for a greater or less period. Both very wet and very

dry weather seem to be detrimental to the eggs of this locust; and a combination of hot and wet or cold and wet have a like effect. Though in the latter instances many are destroyed by molds.

During the past year in certain localities about General Acha in Pampa Central where the eggs were deposited in sandy soil many of them were blown out of the ground, while others were so deeply buried that they either failed to hatch or the young to reach the surface.

Neither can the saltonas when first hatched withstand much heat combined with drought. The present season we had an excellent proof of this assertion in the provinces of San Juan and Mendoza where they hatched in large numbers all through the foothills along the eastern slopes of the Andes. On account of the failure of rains at the usual season nearly everyone of them shrivelled up and died. This condition of affairs I was informed existed for several hundred miles north and south. Even round about Carcaraña and at other places in the provinces of Santa-Fé, Córdoba, Entre Ríos, Buenos Aires, and Pampa Central, like dying off of the young saltonas was observed and reported by correspondents. Personal observations also confirmed these reports. On the other hand, very wet and warm conditions when combined had a tendency towards developing disease among the insects. Wet weather in some localities also favored the entrance into their bodies of the hair-worm which is described in another chapter.

Even the winged insects cannot withstand all kinds of climatic changes without suffering from the effects of them. They can be killed by heat and cold, by very wet and by very dry climatic conditions. Only last week, the latter part of January, I learned of the presence of large numbers of the voladoras piled up in windrows among the snow-drifts high up in the Andes where they had perished in their attempts to cross the Cordilleras. To-day (February 2nd) there are hundreds of dead locusts lying about the streets of Carcaraña and camp in the immediate vicinity that were drowned by the long-continued and heavy rain of yesterday and last night.

If the weather be too dry when the insects are passing through their last molt large numbers of them die because they cannot perform the arduous task, while others are left in such a crippled condition as to leave them no better off as locusts than they would be had they died along with their more fortunate relatives.

About Carcaraña and several other localities in the Republic, hundreds of the winged insects are to be seen in which the wings are not more than one-half or three-fourths their proper length. This is on account of the lack of moisture. Of course these short-winged and crippled individuals can never return to the winter quarters and must eventually fall prey to birds and other natural enemies without propagating their kind. One of these short-winged individuals is shown in plate 26.

Favorable and unfavorable winds for the migrating insects might also be classed under the present heading, since they affect favorably or unfavorably the insects which comprise the invading and returning mangas mentioned on another page of this report.

During the past spring, while the locusts were retained in their winter-quarters rather longer than usual, when they did begin their advance they were favored with northerly winds to such an extent that they were enabled in a very short time to penetrate to regions further south than at any previous time so far as records show. Instead of the bulk of eggs being deposited in several of the nearer provinces they were scattered far and wide so as to be pretty evenly distributed over the greater part of the Republic. In this manner the very favorable winds in spring have been the means of placing the pest at the mercy of its natural enemies over a greatly extended area. Besides, so many of the young will have been reared at such great distances from the natural wintering quarters, that only by similar favoring circumstances can they be expected to return before winter overtake them.

CHAPTER V

Remedies. — Natural.

Aside from man with the numerous contrivances which he has perfected for destroying destructive locusts in all their stages there are hundreds of birds, mammals, reptiles, insects and other animal forms which also spend the greater portion of their lives in capturing and devouring these insects either as eggs, saltonas or voladoras. These latter agencies alone could, and usually do keep the non-migratory kinds within certain harmless bounds. But the migratory forms sometimes baffle all of these natural enemies by launching into the air and leaving them behind.

Although, as just stated, most of these natural enemies are often left behind by the locusts, they nevertheless do excellent work. By paying some little attention to the subject and learning something of the habits of these locust-destroying friends man can frequently assist them in their good work and at the same time help himself. By learning to distinguish the useful from those that are the opposite he can protect his friends and destroy his enemies. He can also, by a very little study, learn something of the habits of the locust to be fought and in ascertaining this can the more readily select his remedies of an artificial nature.

Once a locust become a plague it requires considerable energy on the part of man to reduce its numbers sufficiently to render it harmless. Beyond a certain point all the increase in an insect-pest is just that much gain on its natural checks. To bring it back to and below this danger-line is of the first

importance. This can be done in many ways, as is the following chapter's aim to show.

In order to gain the best results, however, everything should be done in accordance with the insect's habits and life-history. Hap-hazard remedies may or may not be of use in the fight. Where nature can be made or assisted to do the work for us so much is gained; but when this cannot be done artificial methods alone will win if persisted in and followed aright.

Invertebrate Enemies.

It is a well known fact, among naturalists at least, that all kinds of animals, whether they be insects, molluscs, reptiles, birds or mammals, or for that matter, any of the remaining groups, have their natural enemies. Should anyone care to learn whether or not destructive locusts are included under this rule it might be well for such a person to read the chapters devoted to the invertebrate and vertebrate enemies of the Rocky Mountain Locust (*Melanoplus spretus*) as published in the first annual report of the United States Entomological Commission, chapters XI and XII, pages 284 to 350. Since these chapters were written it is but just to say that much additional information on the same topic has accumulated so that what is there recorded could be greatly extended.

Although comparatively little has thus far been written on the natural enemies, insect and other, of the locust now under consideration, it can be taken for granted that it has equally many if not more of them than the insect above referred to. The Rocky Mountain Locust is a native of a comparatively cool country, while the Argentine species is confined more to a subtropical region where animal life of all kinds is very much more abundant.

Some of the invertebrate enemies of this last named insect are already known and the following may be mentioned here as being among the more important.

Hair-worm parasite.

Mermis acrydii? — Quite an important internal enemy of the destructive locust of Argentina is a species of nematode such as is ordinarily called a hair-worm. This parasite attacks both the saltona and the voladora, and in each instance usually fills the entire abdominal and thoracic cavities. It is white and somewhat thicker than a hair from the tail of a horse, and varies in length from 6 or 8 to as many as 75 centimeters. Usually but a single parasite of this kind infests the body of a locust, though quite often there are two, three or more.

The entire life-history of these parasitical worms is not definitely known, but the little we do know seems to indicate the following mode of life:

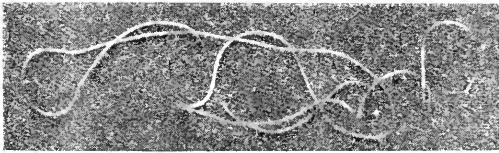


Fig. 9. — Hair-worm parasite of the *Schistocerca paranensis*, from photograph. Original.

“ The *Mermis* acquires full growth within its host, and then forsakes it by boring out with the head. All the specimens so leaving their victim are sexless, and are characterized by a mouth consisting of a very small aperture at anterior end, and by a minute anal point, which is usually covered. Unless they are full-grown when the host perishes, or unless they reach moist earth, these asexual worms perish; but if full grown, and they succeed in reaching the surface of moist ground, they at once bore into, and bury themselves out of sight. Here the sexual organs are developed from a fatty body that the parasitic form contains, and after undergoing one molt the perfect and sexed form is assumed, and the anal end becomes rounded and loses the minute point. During this underground life, no food seems to be required, though several months elapse, and the winter is passed before the animal procreates. * * * * * The female lays her eggs in the ground. The young, which

are filiform, like the parent, at once worm themselves to the surface, and enter, as parasites, various soft insects, and mostly those that are found under leaves, moss, etc., near the ground."

From the above described life-history of *Mermis* it will readily be seen how adaptable it is to that of the locust. Each female *Mermis* is similar to *Gordius*, lays millions of eggs. In spring, after the rains have moistened and mellowed the ground the little larval worms work their way to the surface by myriads; and where they happen to come in contact with a manga of young locusts some of them succeed in gaining an entrance. Once within the body cavity of the host they begin feeding upon its fluids and, growing very rapidly, soon filling the space occupied by them. This drain on the insect's vitality soon causes death, in many instances even before the parasite has attained its growth. Others of the hosts, although becoming enfeebled and ceasing to feed, do not perish till after the fully grown worms have left their bodies and entered the ground.

So near as I have been able to ascertain, this parasite, when infesting the saltonas is invariably fatal. The time they entered the saltonas the present season must have been soon after hatching, for the insects began dying in large numbers during their 3rd stage; and a few only of those attacked reached the 4th saltona stage.

When attacking the *voladoras* this parasite does not seem to at once cause the host to lose its vitality, as the latter frequently makes long flights with one or two nearly full-grown mermids within its body. In this manner the parasites become widely dispersed over the country. An infested insect as a rule does not develop and deposit eggs, but dies without leaving progeny.

It will therefore be seen that this parasite of our locust is a very important one — one that does much during some seasons towards the extermination of the pest. Still, from its nature, and the way it lives, we are unable either to prevent its increase or to make artificial use of it in fighting the enemy. It is one of nature's own remedies which is beyond our interference.

Whether or not there is more than a single species of hair worm concerned in the destruction of our locust, I cannot say, but it is quite evident that both the saltona and voladora are attacked. It is also certain that the worms found in the voladoras are much larger than those that occur in the bodies of the saltonas.

In other countries locusts are often infested by another genus of these hair worms viz., those known as *Gordius*, but these are aquatic save when living in the bodies of their hosts. Perhaps some of the Gordii also thrive in the Argentine Republic.

Locust Mites.

Very frequently the voladoras are infested with certain small, red, tick-like creatures, or mites, and less often these same parasites may be seen clinging to the legs and other parts of saltonas. Different writers mention at least two distinct species of these parasites that have been known to attack our locust.

During the past year the writer has seen but few of these mites and therefore has not had an opportunity to study their life-history.

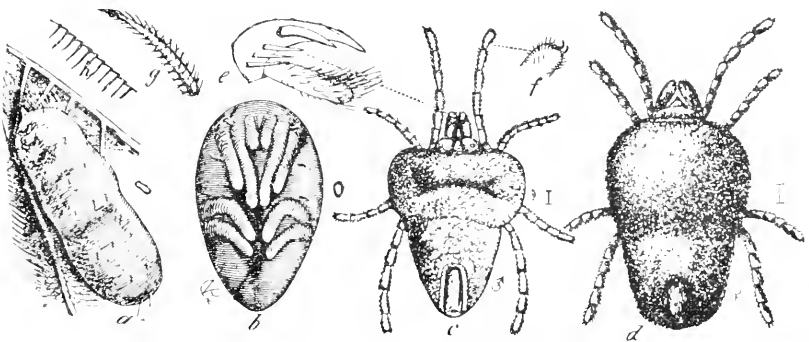


Fig. 10. — *Trombidium locustarum* *a*, or Locust Mite; *b*, the larva as seen on locust's wing; *c*, male, mite; *d*, female, the two latter as they appear when egg-destroyers—all greatly enlarged. After Riley.

But, if they are at all similar in habits to those of allied species which attack the Rocky Mountain and a few others of our North American locusts, they are an important enemy which at times do much to check the increase of the pest.

The two species of the locust mites that have been described as enemies of *Schistocerca paraneusis* in this country are *Trombidium acridii peregrini* and *Trombidium elegans*.

These mites, unless excessively numerous upon the locusts, have but little effect on their hosts. If, however, they are present, as they sometimes are, by the hundreds, they worry the host to death. It is not by their attacks on the locusts themselves that these mites render us a service, as will be seen from the following brief summary of the life-history of *Trombidium locustarum* of North America which is also figured herewith.

“ One of the most interesting as well as one of the most important of our locust enemies is what we may popularly call the “Locust Mite”. It forms a true link between those articulates which prey on the locusts, and those which attack and destroy its eggs, since it combines both traits. * * * * * In the mature form it lives in the ground, feeding upon all sorts of animal and decomposing vegetable matter. When the locust fills the ground with its eggs this mite flourishes upon the abundance of food which these afford, sometimes teeming to such an extent as to give the ground a scarlet hue.

“ In spring, the female lays between 300 and 400 minute spherical orange-red eggs in the ground. They are usually from one to two inches beneath the surface and in a slightly agglutinated mass, which, however, easily becomes scattered upon disturbance of the soil. From these eggs, in due time, there hatch little orange mites which differ from the parent in having but six legs. * * * * *

“ Active when they first hatch and impelled by instinct, these little six-legged specks crawl upon the locusts and fasten to them, mostly at the base of the wings or along their principal veins, just as a tick fastens to a dog or sheep, or to man. Thus attached to their victim, they suck its juices and swell until the legs become invisible.

It is in this condition that they are most often noticed, presenting to the ordinary observer the appearance of a bright red oblong-ovoid body growing from the wing. They are so firmly attached by the mouth, so immovable, and with the legs so short and hidden that persons unfamiliar with their true nature might easily mistake them for some natural growth or excrescence.

“ In due time, these swollen bodies let go their hold and drop to the ground, where, clumsily and with difficulty, they crawl under the first shelter afforded by some bit of loose earth or a stone. Here they remain quiet for two or three weeks gradually swelling and changing in form. During this change the

pupa state is assumed, but not by shedding any skin, as do true insects in going through their transformations. New legs, feelers, and mouth-parts form under the old skin, which, with its now useless legs, distends so as barely to cover the new parts, which are all appressed to the body very much as in the pupa of a beetle. Finally both the distended larval skin and the new one that incases the pupa burst, and release a creature quite different * *. The mature form passes the winter in the ground, and is active whenever the temperature is a few degrees above freezing point”.

In the United States it has not infrequently happened that these mites alone have almost exterminated the destructive locusts over considerable tracts of territory.

Their habits of clinging to the legs and wings of the voladoras insures their being carried from one part of the country to another so as to be on hand where eggs are deposited.

Anthomyia — Sp.

In a chapter devoted to a description of insect and other enemies of the Rocky Mountain Locust, Professor C. V. Riley

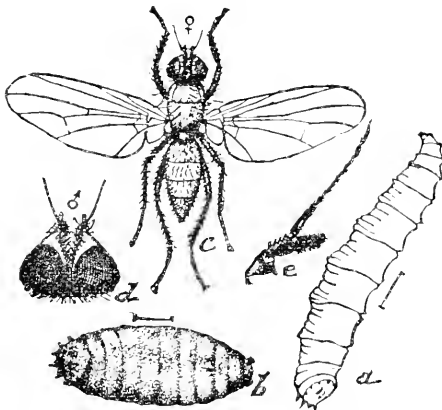


Fig. 11. — *Anthomyia* Egg-parasite: a, larva; b, puparia; c, fly—all enlarged.

writes “This (*Anthomyia angustifrons* Meig.) is, perhaps, the most common and wide-spread of all the different egg-

enemies, and in the fall of 1876 it destroyed on an average about ten per cent. of the eggs in Missouri, Kansas, and Nebraska, and in some localities a much larger percentage. It was also quite common in Iowa and Minnesota, and, as we learned during the past year, occurs in Colorado and Texas. It is doubtless this species which our correspondents in many cases refer to by the general term of grubs, white worms, &c., as the cause of the non-hatching of eggs."

This little grub or maggot is of the same general form as the common meat-maggot, but, when full-grown measures not more than 5 to 7 millimeters in length. They are found in the cartuchos" or egg-pods of the locust either singly or in numbers.

Here in Argentina a similar insect has been ascertained to exist and to be occupied in the same good work. The accompanying illustration (Fig. 11) will give the reader some idea of its general appearance, although it may not be of the same species. Specimens of this insect were seen by the writer that were reared from eggs taken here at Carcaraña in 1896. While Mr. Oliver C. James speaks of the insect in an article entitled "Locust Killers" which was printed in the Review of the River Plate for Saturday, September 5th, 1896.

Blister or Oil Beetles.

The "Bicho moro" or gray blister-beetle, which is often so numerous and destructive here in various parts of the Republic, deserves a "passing notice" at least, when writing of the insect-

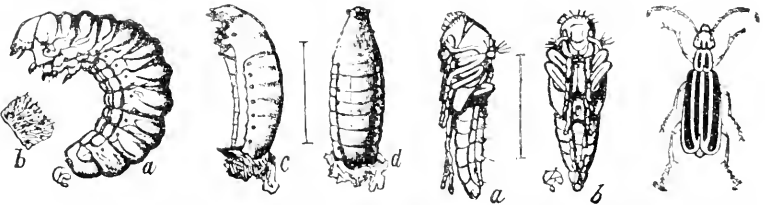


Fig. 12.—Various stages of growth of Egg-destroying Blister beetle. (After Riley.)

enemies of destructive locusts. In North America it has been ascertained that a number of kinds of these blister-beetles, in

their larval stages, feed upon the eggs of various locusts. Especially is this true with respect to those species which are most nearly allied to the gray, black-dotted one found here. Although this insect, has not, to my knowledge, been taken as an enemy of the destructive or other locusts of the country, judging from analogy, it is fair to presume that it has a similar habit to that possessed by its northern relatives. All the blister beetles of which the life-histories are known are parasitic or predaceous during their larval life; hence, the "bicho moro" if not an enemy of the destructive locusts must most assuredly live upon some other insect form or forms that are relatively plentiful. It must by some good deed partially offset the harm it does by feeding upon our garden and other plants.



Fig. 12 1/2. — "Champi" or Trox.

"Champi."

The "Champi" of the natives is a very important enemy of *paranensis* here in Argentina. It has been especially active during the past few months in destroying the eggs of this locust. Both the mature insect and its larvæ or grubs feed upon and destroy the eggs of the acridian in large numbers.

These beetles (for there are more than a single species which possess this habit) belong to the genus *Trox* of the family Scarabæidæ. Ordinarily these insects feed upon dead animals and animal-matter that has become more or less desiccated. How they have developed the habit of feeding upon

locust's eggs in this and not in other countries is more or less a mystery. Still, by a little supposition, it might be imagined that the steps from a carrion-feeding habit could develop that which the insects now possess. In a country where, in former days, and even now, hundreds and thousands of dead animals were and are left lying scattered over the pampa to decay and dry up, these insects have become exceedingly plentiful. Locusts visit the region and deposit their eggs which are covered with a frothy exudation that soon becomes strong smelling and attracts the "bichos" as they go flying about the country in search of food. They alight and begin devouring this "plugging" material and soon reach the eggs beneath. Their own eggs have also been laid and the young grubs already hatched, since carrion-feeding animals must necessarily develop rapidly. They cannot leave, hence the eggs of the locust are attacked and eaten.

Here at Carcaraña immediately after the locusts had begun to gather in certain localities for egg-laying these *champi*s could also be seen in large numbers at the same places. After the locusts had laid and departed, thousands of the beetles were to be seen creeping about over the surface of the ground, while others had already burrowed into the earth and were engaged in feeding upon the locust-eggs and the surrounding spongy material. In about three or four weeks later hundreds of their larvæ or grubs could also be found by digging in the ground among the locusts' eggs. In some places nearly all, while in others, a large percentage of the eggs were destroyed by these beetles and their larvæ.

Not only did the champi destroy large quantities of locust eggs here in the province of Santa-Fé, but according to both private and press-reports it was equally abundant throughout the country, where it did good work. Reports of this kind came from the provinces of Córdoba, Mendoza, San Luis, Buenos Aires and Pampa Central.

So long then as this country remains as at present a stock-producing one, and the carcasses of dead animals are permitted to remain upon the surface unburied, this insect can be counted upon as a locust enemy. That is, provided the locust is permitted to continue to come and go nearly unmolested by man. This habit in the champi instead of dying out will become stronger and more confirmed year after year.

Tachina - flies.

Very frequently we meet with individual specimens of locusts that are more or less "dumpy" or sluggish in their movements. When we capture and open them we find one or two short, thick, whitish grubs or maggots in the region just behind the head. These are the young of gray-colored, two-winged flies, which very much resemble the common house-fly in appearance, though they are usually somewhat larger and more robust. These flies belong to a very large family of parasitic insects known as *Tachinidae*, and are found quite generally distributed over the earth's surface.

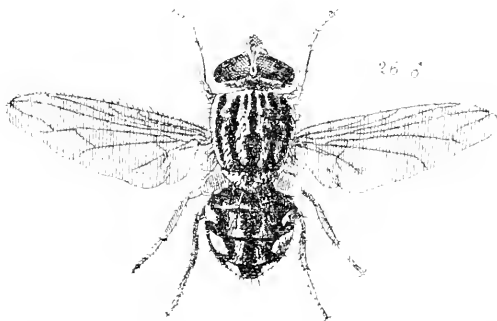


Fig. 13. — *Nemora acridiorum*, male—enlarged 3 times.
After Conil.

At least two distinct species of Tachina-flies are known to attack the locust here in Argentina and the surrounding country. The most important of these is the *Nemora acridiorum* of Weyenburg.

Generally speaking, these Tachina-flies are the most important insect-enemies of locusts in all countries. At times, from their attacks alone, severe locust-plagues are brought to an end.

As the writer has not had an opportunity of studying these Tachina-parasites of the locust in this country during the year, and since several other writers have fully described them, a general account of these insects will be given instead.

“These Tachina-flies firmly fasten their eggs — which are

oval, white, and opaque, and quite tough — to those parts of the body not easily reached by the jaws and legs of their victim and thus prevent the egg from being detached. The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them haunted by a *Tachina*-fly, will make to evade its enemy. The fly buzzes around, awaiting her opportunity, and when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily, she has even greater difficulty; but, though the locust tacks suddenly in all directions in its efforts to avoid her, she circles close round it and generally accomplishes her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or hop. The young maggots hatching from these eggs eat into the body of the locust, and after rioting on the fatty parts of the body — leaving the more vital parts untouched — they issue and burrow in the ground, where they contract to egg-like puparia, from which the fly issues either the same season or not till the following spring. A locust infested with this parasite is more languid than it otherwise would be; yet it seldom dies till the maggots have left". Often in pulling off the head or wings of a locust from which the maggots have escaped, its body will have the appearance of a mere shell. So efficient are these parasites that quite frequently the ground in locust-infested regions is covered with dead and dying locusts.

"In warm weather, these flies multiply very rapidly, undergoing all their transformations in the course of a fortnight from leaving the egg; but in the cooler seasons the pupal development under the ground is much slower, and the winter is generally passed in the puparium, though we have known the larvæ to remain in the ground unchanged all through the winter".

Since all of these flies are less hardy than most migratory locusts, and, as a rule, require a moister climate in which to live, they only occasionally succeed in checking the pest upon which they live. If the locusts could be placed in a humid locality and kept from migrating for several years these *Tachina* flies would end the plague. In some parts of North America even these flies possess a migratory habit, large swarms of them having frequently been observed following locust-swarms.

Flesh - flies.

In addition to the Tachina-flies described above, there are other flies which greatly resemble them, that also attack locusts. In writing of these latter flies Professor C. V. Riley says: "They greatly resemble the preceding in general appearance, but may be distinguished by the style of the antennæ being hairy instead of smooth. Judging from the accounts of correspondents, and the well-known habit of breeding in dead and decomposing animal-matter, which these flies

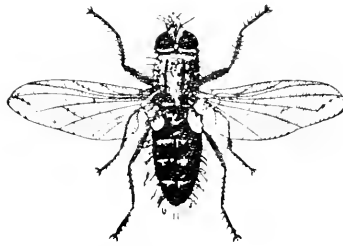


Fig. 14. — Flesh fly or Locust parasite.

possess, they are usually attracted to those locusts that are feeble or already dead, and are fond of laying their eggs on specimens which have just molted, and are yet pale, soft, and helpless". Many locusts that are suffering from the various fungus diseases to which they are subject, also are attacked by these flesh-flies. The *Calliphora interrupta* mentioned and described by Conil in his treatise on the Argentine locust is an example of these flesh-flies.

Predaceous Insects.

GROUND-BEETLES. — Many kinds of these beetles are very active in pursuing and killing the saltonas of both this and other locusts; and the good they do in this way is very considerable. The smaller species of these beetles (*Carabidae* and *Cicindelidae*) attack the quite young saltonas, while the larger

ones carry on their work of destruction among the ranks of those that are one-half to full-grown.

Not only do these predaceous beetles kill and feed upon the young locusts, but many of them, in their larval state, also feed on locust-eggs. Some of them are particularly useful in this direction.

ROBBER-FLIES. — These large, fierce, hairy flies are exceedingly fond of the young locusts which they pounce upon and seize as a cat would a mouse. When once in their possession they fly off to some spot upon the bare ground or to the stem of a plant, where, unmolested, they can suck the juices of their victim. At least four or five distinct kinds of these flies have been observed to capture the saltonas of our locust; and undoubtedly most of the larger species do likewise, since it is

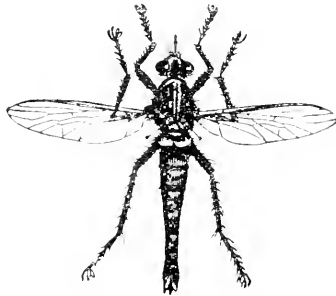


Fig. 15. — Robber Fly.

a common habit among the North American representatives of the family (*Asilidae*).

OTHER INSECTS. — Still other kinds of insects are also known occasionally to destroy saltonas of various species of locusts. Some of these are the preying mantis, different kinds of ants, and several of the predaceous bugs (*Heteroptera*).

Of course we cannot hope for relief from the locust-plague to come by the efforts of these predaceous insects alone. Still, by knowing that there are so many and varied agencies at work, we can take new courage and fight the more faithfully ourselves, knowing that when once reduced to a certain point these natural enemies of the locust will keep it within proper limits.

Digger Wasps.

Not only does our locust suffer from the attacks of dipterous parasites, but large numbers annually perish from the attacks of different kinds of digger-wasps of which there are many species here in the Republic. One of these wasps in particular, a moderately large black-and-red insect, is a noted enemy of the locust since it seems to employ them only as nourishment for its young. It uses both saltonas and voladoras for this purpose.

As a cat pounces upon its prey, so does this wasp spring upon its victim. After stinging so as to paralyze it the wasp carries its captive to some suitable spot and buries it along

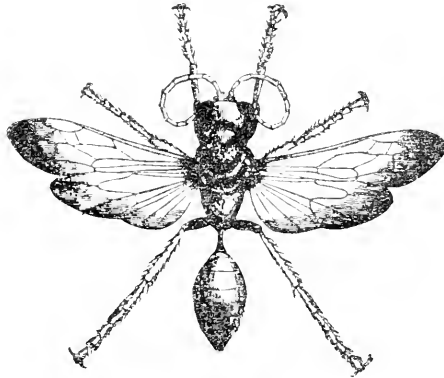


Fig. 16. — Digger Wasp.

with an egg of its own. This egg soon hatches out a footless grub that proceeds to eat the locust which still lives in a semi-torpid condition. When the larval wasp is full-grown it spins a silken cocoon and remains in the ground till the following spring to issue forth upon conquests of its own. If the migratory locust does not happen to be present in the region, this wasp is satisfied to supply its young with some native "grasshopper" instead.

So rapacious is this wasp that it occasionally rushes in among a group of full-grown saltonas, and pouncing upon one

after another and stinging them soon has laid out a dozen or more victims. After the assault has been made the wasp leisurely selects one from among them and marches off with it to some suitable place where it is buried as described above. Like some animals of prey this digger-wasp often apparently destroys locusts simply as a pastime or maybe for practice. The name of this wasp, according, to Conil, and others, is *Enodia fervens*.

It belongs to a rather large and well represented family of solitary digger-wasps which naturalists call *Sphagidae*. While this particular species of wasp seems to be partial to locusts as a diet for its young, it is by no means the only representative of the family here in Argentina that attacks locusts for this purpose. At least a half dozen others are likewise enemies of the dreadful pest.

In addition to what these *Sphagidae* do towards killing off the pest, there are also representatives of at least two other families of solitary wasps which likewise supply their young with locusts for their nourishment. These are the *Larridae* and *Pompilidae*.

While all of these wasps, even when working together, can do comparatively little towards keeping the locust-plague in check, they help to do so, and it is but proper that we should recognize in them friends worthy of our sympathy and protection.

Digger-wasps "by means of their powerful jaws and spinous legs burrow with great rapidity in the ground, where they form a sort of nest; provision it with some kind of prey which they have stung and paralyzed; lay an egg thereunder, and cover up the hole — the larva when it hatches feeding upon the food thus provided by the parent".

Vertebrate Enemies.

Birds.

Birds stand at the head of the vertebrate enemies of locusts. In fact they are so persistent in their search for and destruction of insects that they have rightfully been called the "balancers" in nature. In a wild state, and where not interfered with by

man, this balance between animal and plant life is seldom set to vibrating. Not only do birds feed upon the insects that would destroy these various plants if left to themselves, but they also pick up the extra seeds of weeds that are so thickly strewn over the surface of the ground. Here too do birds assist in keeping things balanced.

Birds are intelligent creatures; are provided with musical voices, beautiful forms, gay dresses, and, as a rule, with delightful tempers. They are just such creatures as can best endear themselves to the human race. They do not come "a begging" for their keep on account of these pleasing characters which they possess and give us the benefit of. Far from it. Instead of asking pay for the cheer they carry with them wherever they go, they pay well for the privilege of making us feel happy. They are not confined to one locality or a comparatively restricted area like most other animals, but by means of their wings can go where they choose or where duty calls. Neither are birds without judgment. When food of a good quality is plentiful, they do not waste time in searching for that which is scarce. If some particular insect becomes abnormally abundant, this is the one attacked in preference to others until it, like the others, has become normal in number.

In their food-habits, birds like all other animals, have their preferences. Hence, we find that some particular ones, among the many, are especially fond of locusts as a diet; and that these often leave home and family to find and feed upon the locust-warms. An example of this fondness for a particular kind of insect food can be seen in the great flocks of the large brownish hawk or buzzard known in the country as "gavilan". These birds are always to be found where there are mangas of the destructive locust. They gorge themselves till they can scarcely fly. Yet in an hour or so, they again "fill up" with locusts, and keep on doing so day after day. I have known a flock of these birds to completely exterminate a very large manga of the saltonas of *paranensis* in a few days, only to remove to another, not far distant, where they are engaged in killing and eating locusts as these lines are being penned.

Others of our birds like the "Carancho", "Chimango", "Gaviotas", "Ostrich", "Martineta", "Perdiz" and "Perincha" or "Urraca" are likewise great lovers of a locust-diet; and it is through their services chiefly that the native locusts or "tucuras" are not more frequently destructive.

Numerous reports testify to the excellence of the native ostrich, or Rhea, as a locust destroyer. In addition to their special fondness for locusts as food, their large size and corresponding capacity render them especially efficient in this direction. Besides, it is a true dweller on the pampas, and almost the only bird that seems to require no water. Only the other day the following account of this bird as a locust destroyer was published in the columns of the *Standard*: "A swarm of hoppers, which covered an approximate radius of twenty squares long by two wide, was completely destroyed in five days by forty-five ostriches". The "Martineta" and "Perdiz" both feed almost exclusively on locusts during the summer and fall months, while the latter has several times been reported by our correspondents as a great destroyer of locust-eggs, which it digs up with its beak. It is possibly the destruction of these game birds, to a large extent at least, that has produced the great increase in the destructive locust during the past decade.

The food of many of the water birds, likewise of nearly all of the smaller song birds, at times, if not during the greater part of the year, is composed of insects. It is but natural to suppose that a large percentage of these insects are various kinds of locusts. Especially is this the case while the locusts are in the saltona state. This being true, it is quite likely that the most abundant of all locusts, the *Schistocerca paranensis* of Burmeister, should come in for its share of persecution.

One species of "gaviota" or gull at least has been reported time and again, to eat until full, then to disgorge and begin over again, only to repeat the operation during the entire day. In one section of North America, too, the gulls in days gone by, have come to the relief of the settlers when they were being robbed of their crops by a large wingless orthopterous insect. In this case, however, the birds had been protected by law from the unscrupulous sportsman.

Some time ago a certain person advocated, through the medium of the newspapers, the introduction into the country of the Starling as a means of ridding the country of the destructive locusts. The idea was an excellent one. Perhaps he was not aware that in the several species of "Pecho-colorado" and the "Pecho-amarillo" we not only have equally active enemies of the locust, but also representatives of the European starling as well. These starlings are among the most useful of insect-destroyers; and, going in flocks as they do, they are especially

fond of the insects that have become abnormally numerous, since they provide abundance of good food.

In the United States, it has been estimated that in at least one state (Illinois) there is an average of three wild birds to the acre, excluding the water fowls. Taking these figures as a basis for comparisons we can readily see what the bird-life of Argentina might be. In making these comparisons the fact that Illinois is a "prairie state" should also be borne in mind.

This country (Argentina) contains, according to Rand & McNally's pocket-atlas of the world, one million, one hundred and twenty-five thousand and eighty-six square miles which is equivalent to seven hundred and twenty million, fifty-five thousand and forty acres. To keep entirely within the truth and at the same time avoid fractions, we will suppose that there are only five hundred million (500,000,000) birds including domestic fowls to be found in all Argentina. Allowing each of these a full-grown locust daily it would take 1,250 tons of 400,000 locusts each, simply to go round. Could this number of birds be doubled this increased number would require twice as many locusts or 2,500 tons daily. This increase in the number of birds could be obtained simply by each person seeing that he himself killed no bird or birds for a period of two years.

Of course there are many birds in the country which are quite small and do not eat so large an insect as a full-grown locust. There are others, however, like the ostrich, gavilan, carancho, chimango, martineta, perdiz, gulls, geese, turkey, hen, ducks, and dozens of others that not only eat one but scores of full-grown locusts daily — sufficient of them to even up for those that do not do so.

Judging from what I have seen of the people during the few months I have remained in the country, they are especially fond of birds of all kinds. Hardly a family but has one or more kinds of birds in cages about the house or garden. Why then do they permit the wholesale slaughter of these beautiful creatures which they love? It can not be that they are ignorant of the fact that this very thing is going on in their midst from the beginning to the end of each year. I cannot understand it. Every boy who is old and big enough to wield a piece of wire, a stick, a rubber-sling, or whatever it may be, that can kill a bird, spends much of his time in persecuting these useful and lovely creatures. The older boys and men use guns, boleodoras, etc. Nests are rifled of eggs and young alike

seemingly only for the purpose of killing something. Birds are not alone among the victims that are claimed to satisfy this inborn desire for killing. Every toad, frog, lizard, mouse, weasel; in fact, anything, save really injurious animals, seems to be pounced upon and destroyed whenever and wherever encountered.

It cannot be for securing food that this reckless and wanton destruction of life goes on, for not one in ten of the animals thus destroyed is eaten or intended for this purpose. If only this same craving could be satisfied by the death of locusts how quickly could the locust-plague problem be settled. Equip the boys and men with death-dealing devices and turn them loose in a close manga of the voracious acridian and how the "angel death" would enter his ranks! There would be carnage enough, methinks, to satisfy the most fastidious.

Joking aside. This state of affairs must be changed; and until it is, the people of Argentina, and for that matter of any country where like conditions exist, will be obliged to suffer from the ravages of locusts and other insect-pests. Not only will present conditions prevail, but as time goes on these pests will increase year by year as their natural checks are more and more removed.

Other Vertebrate Enemies.

Batrachians and Reptiles.

Next to birds in their importance, among the vertebrate enemies of locusts, follow quite closely the various kinds of toads, frogs, lizards and serpents. In fact by far the greater part of the food of these animals is composed of insects.

It is needless to state that during the saltona state very large numbers of the destructive locust are destroyed by each class of these animals. The various kinds of toads, especially, are very active destroyers of the pest at this time as I can testify from personal observation at a number of different places in the Republic during the past 40 days. Hundreds of these animals were on several occasions observed in the immediate neighborhood of mangas of the insects. Especially were they numerous

in the Pampa Central about General Acha. Here I must have seen at least two hundred of them in one small field where very many had hopped into a ditch that had been dug to check the onward movement of the marching saltonas. Their imprisonment instead of being a matter to worry about only made their work the easier. When the locusts dropped into the ditch they were eaten one by one as the toads found there was room for more locusts.

Frogs of several species leave the water and scatter out over the land in search of food. Some of these aquatic animals have been observed several miles and even leagues from water. That they find a bountiful supply of locusts for food can be attested by their swelling sides. Lizards, too, capture both the saltonas and voladoras. The writer has frequently seen the common lizard of the pampas with a full-grown *Schistocerca paranensis* in its mouth, which it was carrying as a cat would a mouse. The larger lizards and "iguanas" have similar habits, while it is a well known fact that serpents capture and feed upon various kinds of insects.

The numbers of the locust that must annually be destroyed by these various animals throughout the Republic would most certainly make a difference were they permitted to live and multiply.

Mammals.

Nearly every kind of domestic animal, aside from fowls, is known at times to feed more or less freely on the winged insect. The cat, dog, horse, cow, goat, sheep, hog, and even rabbit, have all been either reported as eating them under certain conditions or have been detected in the act by myself or assistants. The wild relatives of these animals are even more persistent in destroying the locust than are their domesticated allies. Add to these such animals as the skunk, weasels, opossums, the various rodents, the armadillos, and even monkeys, and we certainly have quite an effective army at work on our side.

During a trip made into the Pampa Central it was learned that several guanacos had recently been killed, the stomachs of which were quite filled with fragments of the flying locusts. Even this animal, that some proprietors of estancias had been in the habit of having killed because of its being in the way, has thus been proven useful.

Fishes

Not only do the arboreal and terrestrial animals enumerated above do good work by aiding to rid the country of this pest. Even the fishes and other aquatic animals which inhabit the lagunas and streams assist in the good work. When the wind blows the flying locusts into the water they are quickly seized by the only too eager fishes. While making a journey up the Paraná during the month of September, when the voladoras were moving about, it very frequently happened that many were thrown into the water by contrary winds. At such times it was a real pleasure to see how rapidly they were despatched by the numerous fishes which came to the surface for the food thus provided. At other times it frequently happens that the marching saltonas come to streams of water and attempt to cross. Of course many of them also are destroyed before they can reach the opposite shore.

CHAPTER VI

Artificial Remedies.

It will be seen from the foregoing account of the *natural* checks to the increase of these insects that in nature, under normal conditions, there is no abnormal increase and consequent injury. It may further be seen that, when we have removed many of these natural checks and the insects are thereby permitted to increase in destructive numbers, we must resort to artificial remedies if we would again restore original conditions.

The present chapter will, therefore, be devoted to a discussion of various artificial methods of destroying the locust in its different stages of growth under some of the conditions in which it may occur. We will try to show how the eggs, mosquitos, saltonas and voladoras may be handled at a minimum expenditure of labor and money. These remedies must therefore be selected in accordance with the insect's habits and the governing circumstances under which it is found. In these selections of remedies we must also try to be governed more or less by what is nearest at hand or most readily obtainable at the time and place. Where the expenditure of money can be avoided this should be done, provided good results can be obtained without such outlay.

Destruction of eggs.

In the artificial destruction of locusts the eggs may receive our attention first. On account of the great depth at which

these are placed by *paranensis* the ordinary rapid methods used in destroying the eggs of various of the smaller North American and European species cannot be employed with success here in the Argentine Republic. Then, too, the time of year during which they are laid renders the use of many methods out of the question.

Haud-gathering. — This appears to be the chief method employed here. While it is very slow, it has the advantage of being very efficient so far as it goes. By a little ingenuity on the part of the egg-gatherers, various tools, as spades, shovels, trowels, rakes, etc., can be utilized in facilitating matters. The very tedious method of digging out the *cartuchos* one by one with a knife or trowel is too slow. By first shaving off about an inch of the surface-earth with a spade or shovel and throwing it aside and then taking another layer containing the eggs and loosening it up, a small hand rake can be used for gathering the egg-clusters. For simply destroying the eggs and not attempting to gather them the use of machinery is best.

Machines. — Where it is not desired to collect and sell the eggs they may be destroyed much more rapidly by the use of such machines as plows, disks and harrows. Very deep plowing and afterwards rolling is known to destroy most if not all the eggs in fields thus treated. By plowing them under five, six or more inches and then rolling the ground the young are prevented from reaching the surface even though they should hatch. Very light or shallow plowing and a later thorough harrowing tears the egg-pods apart and exposes many of the eggs to the effects of sun and air. In a dry climate this last method is more effective than where there is a plentiful supply of moisture.

Trampling. — Sometimes it is practical to drive mares or sheep back and forwards over a spot containing eggs. When the ground is soft and wet the eggs may nearly all be crushed, or so trampled into the mud by this method, that few will hatch.

All egg-destroying must be done very promptly after laying takes place, for the time is short for this work. As stated in a preceding chapter, the eggs hatch in from twenty-five to sixty days according to condition of weather and time of year when laid.

Destruction of Voladoras.

The comparatively active nature of the voladoras during most of their sojourn in the settled districts renders them somewhat difficult to handle. Still, by watching and waiting, it will be found that there are a number of opportunities to be had for killing even the winged locusts. During cool, cloudy days in spring, while a pampero is blowing and when it is raining, they can be gathered into bags or killed by means of wire flails, paddles, shovels, and like appliances as they cling in numbers to trees, fence-posts, sides of buildings, walls and other places. Machines like the various rollers and Carcaraña shown in figures 17 to 23 can also be brought into use where the insects are gathered in grass and other low vegetation. By working at night when the insects are roosting much good can be accomplished. Large quantities were thus gathered, bagged and sold to the local commissions during the past year in the colonies of Santa-Fé.

When the insects begin to mate, and also while they are engaged in egg-laying, they gather in clusters upon rather hard, bare ground. They are more inclined to remain quiet at such times, hence can be more readily approached and killed than when wary and active. By taking advantage of the times when they are clustered for the above named purposes, many can be destroyed even during warm weather and the middle of the day. Good results have been obtained by the use of heavy land rollers, wire-flails and similar crushing devices. It has also been found that they can be destroyed in large numbers by trampling them with troops of mares or flocks of sheep.

The most effective time, however, for the destruction of the mature insects is in winter when they are in their hibernating retreats. Here, as before stated, they frequently gather in such numbers as to cover the surface of ground and vegetation to several inches in depth. So numerous are they at times according to reports that a ton may be gathered from ten or a dozen square rods of surface.

Sometimes this wintering takes place in tall grass that is sufficiently dry to burn readily. With a moderate wind to drive the flames great havoc can be done to them in a very short time. More commonly the insects are to be found clustered in

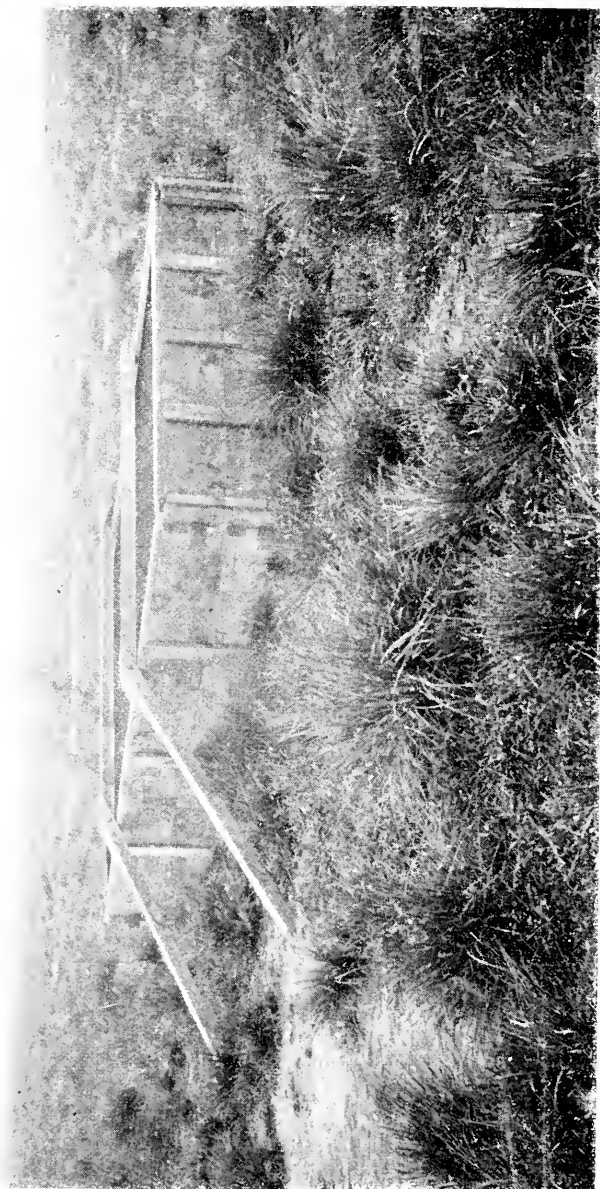


Fig. 17. — Box for emptying Carcarana locust machine into, original.

the scattered "monte" or open woods so characteristic of many parts of the provinces of Santa-Fé, Entre Rios, Córdoba and Santiago del Estero. Here fires are of less practical use and other methods will have to be devised for getting at them. Frequently a sufficient quantity of locusts will gather on several square leagues of country for wintering, to spread over and devastate at least ten to twenty times as great an area later. Last winter, for instance, all of the hibernating insects, with but few exceptions, were confined to a rather limited district in Santa-Fé, Córdoba and Santiago del Estero, and in Entre Rios, with a possibly, third district in Catamarca or Salta. Later, these scattered out so as to cover nearly the whole of the Republic and parts of Uruguay, Paraguay and Brazil, with a few in Chile.

These wintering points should be carefully watched for and reported as early as possible in the season, so as to leave ample time to fight them while they are condensed into as small an area as possible and while they show little desire to get away when approached.

Destruction of Saltonas.

The young locusts or saltonas can be destroyed in many ways, each of which may be more or less applicable to different conditions under which they occur. Some of these methods are burning, crushing, catching or bagging, trapping, poisoning, the use of irrigating ditches, driving etc.

BURNING.—Occasionally it may be found practicable to destroy large numbers of the saltonas by means of fire. When found among dry grasses on the open camp; in pastures by surrounding with dry straw or hay and then lighting the material; by the use of torches made of rags saturated with oil and passed over them; by drawing pans and other devices containing fires over the mangas either by hand or horses.

CRUSHING.—Various means for accomplishing this can be contrived and adopted by those who wish to kill the insects. Where they are on rather firm, smooth ground, heavy land-rollers if passed over the insects will kill most of them. If the ground should be soft and uneven this method would be of little value. If the rollers could be arranged so as to go in

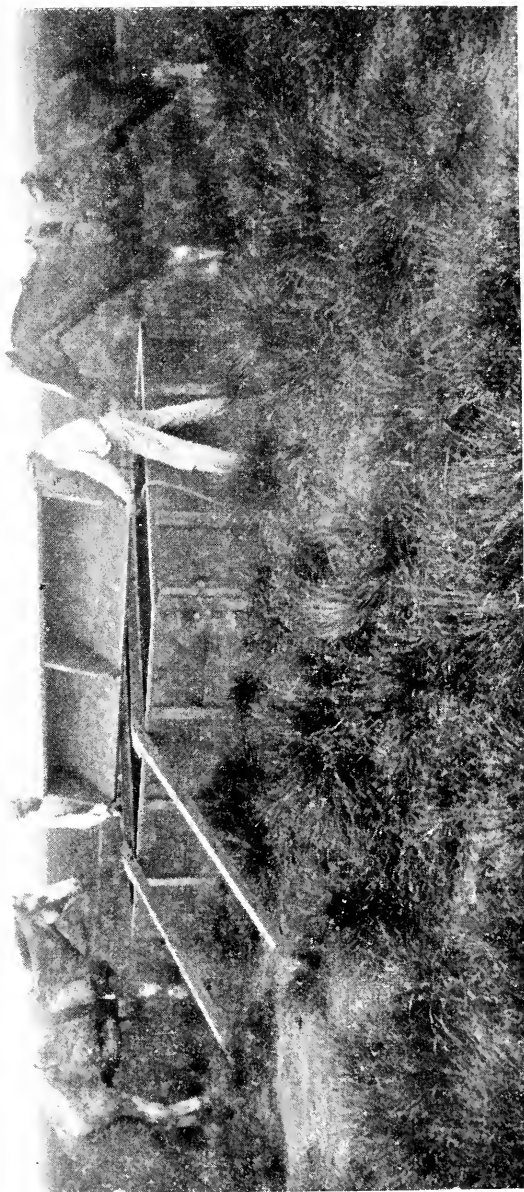


Fig. 18. — Showing method of emptying Carcarahă machine. (Original.)



Fig. 19. — Showing method of working Carcarahá machine. Original.

front of the horses it would be much better, for then the locusts would not be driven away from the machine and more would be passed over and crushed.

As the insects increase in size various roller-machines in which the insects are obliged to pass between revolving cylinders are very effective. They may also be destroyed in large numbers by trampling with troops of mares and flocks of sheep; and by weighting down a fresh hide and dragging it forward and backward over the locality occupied by a manga of the insects.

When the insects are still quite small and cover comparatively little surface; during cool, damp weather when they are bunched; also when they gather on walls and sides of buildings; in close mangas among trees etc. very good results may be obtained by the use of wire-flails, wooden paddles, shovels, bags weighted with sand or earth, small bundles of tough twigs, and any other device that may suggest itself and that can be wielded by hand. Occasionally it happens that one man can do more actual killing in a day by the use of one or the other of these devices than at other times can be accomplished by one or even two of the machines drawn by horses in twice the time. These methods are applicable in gardens, quintas, vineyards, groves, and other places where the large machines cannot be used. They are also very effective during the first week of the insect's life while it is still bunched, and where there are not sufficient of them to warrant the use of the larger machines.

CATCHING OR BAGGING. — When it is desired to gather and bag the insects for securing bounties or for other purposes, this can be accomplished in a number of ways. Some of these methods are the use of machines like the Carcarañá, and nets, sheets of cloth, traps, fences, ditches, pits and the like.

Each of these various methods is good in its own peculiar way and under special conditions. The Carcarañá machine comes into play where the insects are gathered in fields of wheat, alfalfa and like crops where they can climb above the ground several inches. During evenings and early mornings with horses, as shown in the illustrations, the machine is rapidly drawn through the field and the insects captured. From the machines they can be dumped into boxes, pits, or directly emptied into bags. Several forms of these machines may be devised, the only precaution that is necessary is to see that they are made to run as *closely as possible* to the ground because,

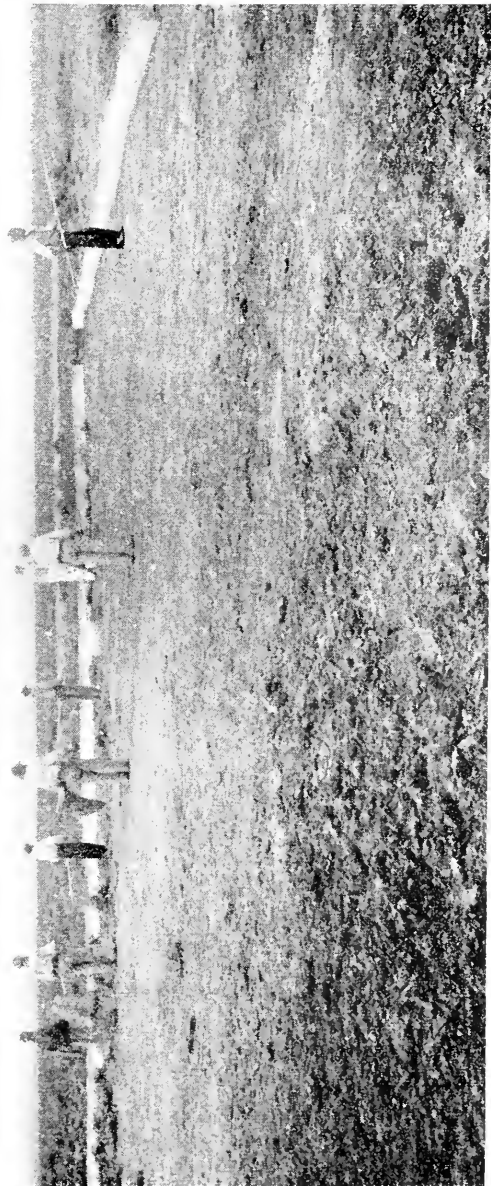


Fig. 29. — Showing method of driving locust. Original

as before stated, our insect is a poor jumper. The machines must be kept in motion while there are insects in them so as to prevent their jumping out.

TRAPPING. — By arranging variously constructed traps in front of marching mangas large numbers of the insects can thus be secured. Under this heading will naturally fall all kinds of fences, trenches, pits and other barriers that at times are used for diverting and concentrating the insects.

A very neat contrivance for this purpose was used on the estancia of Mr. Joseph G. Greenwood at Cañada de Gomez in the province of Santa-Fé during the past spring. It consisted of a box made of boards and tin from the hind end of which branched wings to concentrate the insects and direct them forwards. The box was set at an incline with the front end resting over a barrel or box to hold the locusts that might be trapped. The device for securing the insects consisted of a pane of glass set in front of a hole in the bottom of the inclined, narrow box. Coming to the hole the locusts naturally tried to jump across and on striking the glass fell into the receptacle below.

Fences made of sheets of zinc or tin a foot or fourteen inches in height, of foot-wide boards with narrow strips of tin on top, smooth strips of mortar or tin on walls, trenches with perpendicular or under-sloping sides and a narrow piece of projecting tin above, as well as others, can be used in directing the insects into pits or other places of confinement. When coupled with driving these really form a very important feature in the destruction of our locust in the saltona state.

POISONING. — Under this heading can be included the various applications of poison, as bran and arsenic; arsenic and water sprayed upon the foliage of weeds and other useless plants; the kerosene, creosote and similar "contact" poisons; and the supplying of food-plants which are poisonous to the insect.

Under ordinary circumstances these true poisons are not to be recommended, since with the most of such remedies there must always be coupled more or less danger both to the operator and to domestic and wild animals not intended to be destroyed. The bran and arsenic remedy that has been so highly recommended both in Europe and North America, while very effective, is very dangerous to handle where there are domestic animals of many sorts. As far as most dogs are concerned there would be but little difference; but all kinds of fowls and

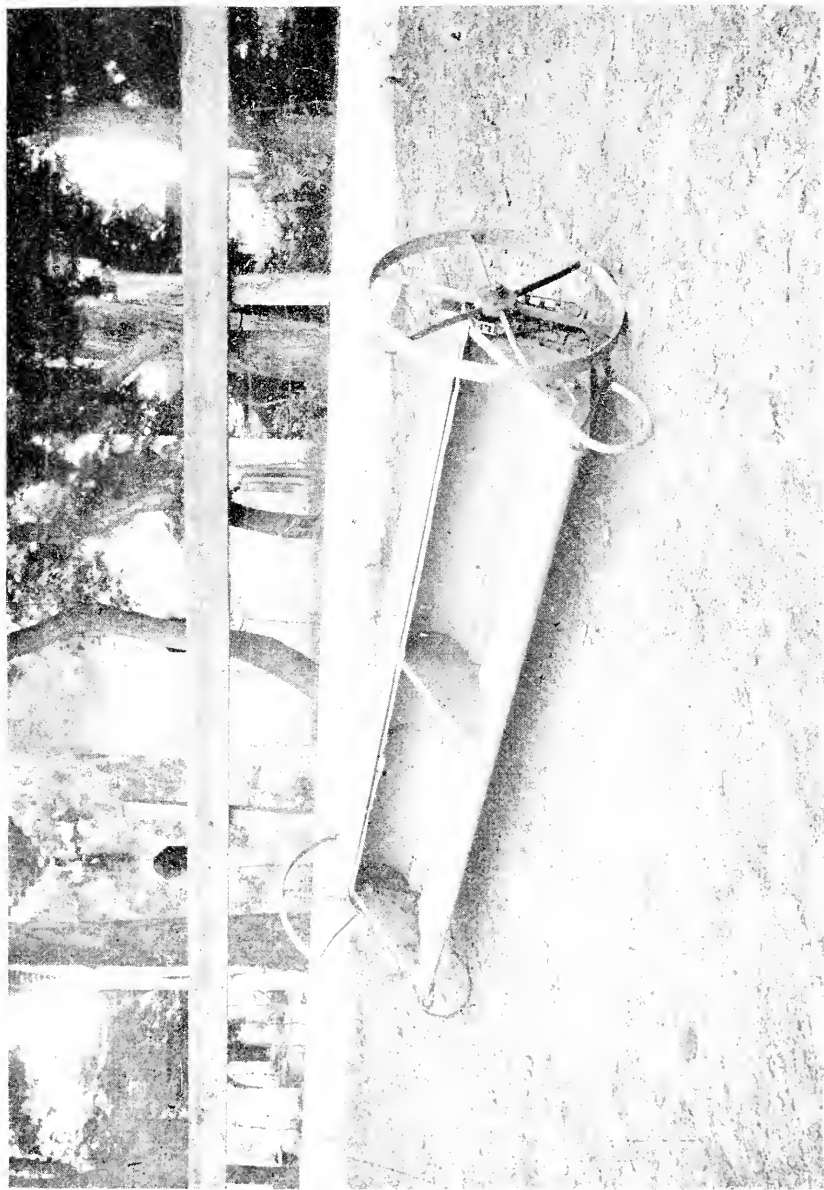


Fig. 21. — Koller-machine for crushing saltomas. (Original.)

many of the wild birds have been known to eat of and be killed by it. Enough birds have been killed on one small garden to have destroyed all of the locusts found upon the same tract of land in several days' time. Arsenic-sprays might be all right in a well-fenced district, but could most certainly not be recommended for open fields and camp where all kinds of stock run at large.

The «contact» preparations are usually too expensive in their application when used against destructive locusts to be of economic value. Some of these preparations in order to *kill* the insects must be made so strong as also to kill vegetation. Of course where all the appliances for their use are at hand, and the insects are condensed into very small space the result often proves quite satisfactory.

From the various hints thrown out in this chapter, as well as in connection with life-history and habits, the reader will gather sufficient information to satisfy himself that there are many ways of killing locusts.

Experiments which were made at Carcarañá, show that under ordinarily favorable conditions the saltonas in their fourth and fifth stages can be caught by driving into trenches for, not to exceed, seven paper dollars per ton; and with the Carcarañá machine for about one and a half dollars per the thousand kilos. Of course these figures represent cases where everything was done in accordance with the insect's habits, and where the work progressed smoothly under proper instructions and supervision. The insects were also present in very large numbers, but were not more numerous than is often the case.

Driving locusts.

One very important method of destroying these insects is by driving them together and into some ditch or pit previously prepared for the purpose. This method is applicable in many places; as for example, in the garden, the field, on roads, the open camp, and even in groves of trees where machines cannot be used. Besides, it is a very inexpensive way of getting rid of small mangas of the insects, and can be done by children and women while the men are engaged in other labor.

It should be borne in mind, however, that there is a right way

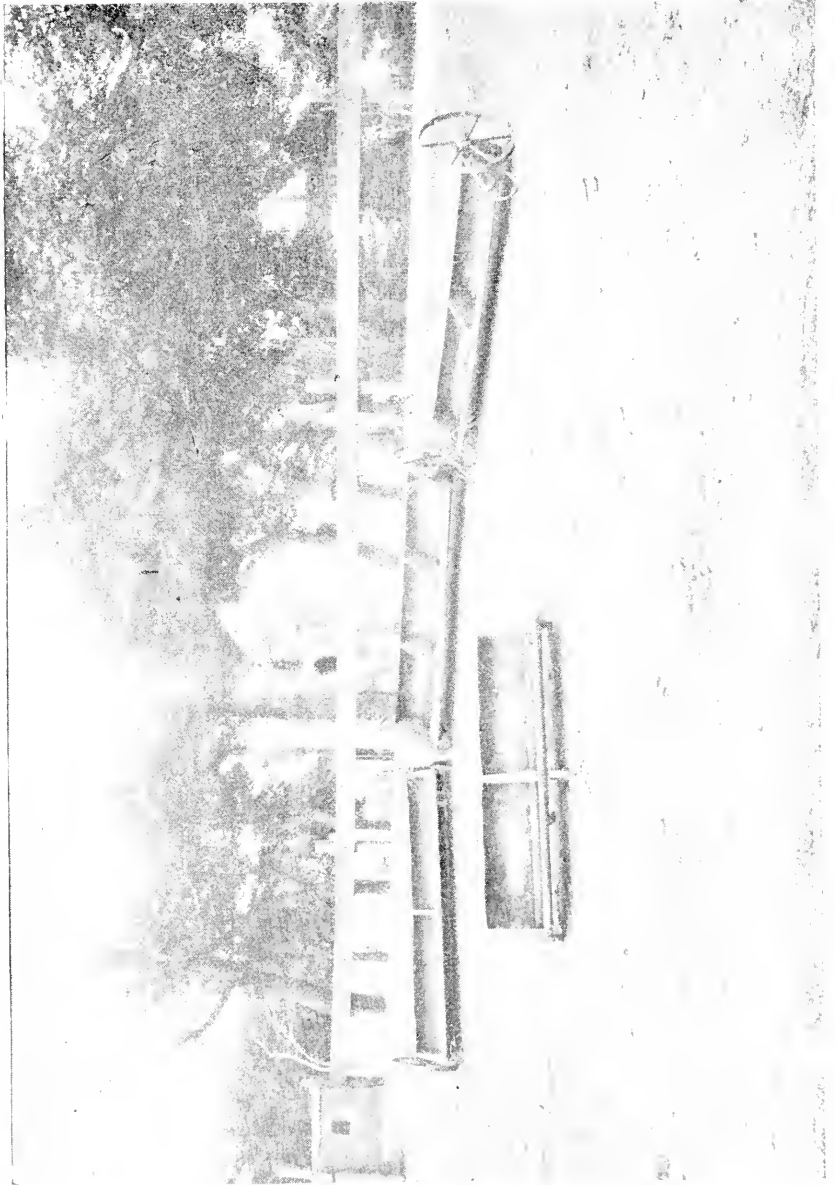


Fig. 22. -- Various types of roller machines for capturing and crushing locusts. (Original)

as well as a wrong one even for driving locusts. This particular locust is not a great jumper at any time, as has already been stated, and especially during the "saltona" stage is it that the insect shows a deficiency in this respect when compared with some of the smaller but more active species of grasshoppers. By remembering this fact, and also that locusts are very easily confused and discouraged, better success can be had. It should also be borne in mind that they cannot be urged forward very rapidly.

In driving them the person or persons performing the task should be provided with some sort of banner or flag for urging them forward. This should be of a color other than green — a bright one being best, so as to be as conspicuous as possible. This should be held in the hand and regularly waved *toward* the hoppers in the direction in which it is desired to drive them. By keeping nearly or quite two meters behind and waving the banner at regular intervals of at least a second or a trifle more, apart, so as to give each insect an opportunity to gain a footing, the entire mass will move forward very regularly and quite rapidly. Should the person approach much nearer and wave his banner more rapidly, the insects would become confused and either dash about in all directions or hide in the grass and refuse to move at all. By going at the work systematically and in accordance with the insect's habits, even locust-driving can be made quite a success as compared with haphazard work. It is especially necessary that the above described method be followed in driving the insects when they are among grass or other short vegetation. It will also work quite satisfactorily when the insects are among taller vegetation and in open groves. If they should become confused while in such situations, or in fact at any time, they would cluster together and refuse to be driven at all or they might stampede in an opposite direction. They are much like sheep in this respect.

Diverting invading mangas of voladoras.

It very frequently happens that swarms or mangas of the insect invade a district from some other region. When such is the case, the flying insects may often be prevented from alighting and inflicting their depredations. At such times fires built



Fig. 23.— Various locust-catching apparatus. (Original).

in localities from which the smoke will pass over the field or plants desired to be saved will cause the plague to move on or swerve aside. Banners of various kinds waved in the hands or tied to sticks, poles, or trees, will also have a similar effect on the moving hordes. Bright-colored banners are best for this purpose since they seem to be more readily observed and avoided by the flying insects. Noises, such as beating with sticks on old tin pans or cans, drums, the discharge of firearms, shouts, etc., may also have some frightening effects on the creatures. A combination of all of these may and sometimes is used; but whether or no with increased effect is a moot-question. That the locust, like most other insects, rather observes *motion* and light than color and form, seems a fact. Hence, banners to be of use in frightening the acridian must be kept in motion. If allowed to droop motionless they will be of little or no use. It has also been ascertained by experience that if the banners are waved or moved too rapidly they are almost as useless as if permitted to remain quiet. The reason for this seems to be the possible confusion of the insects, which when thus disturbed at once alight and endeavor to hide.

CHAPTER VII

Locust killing Fungi

It has been known to entomologists for a number of years that different locusts are subject to the attacks of certain diseases. Some of these diseases are also known to result from the presence and growth within the bodies of the victims of several kinds of mold or fungus. Not only are locusts subject to the attacks of these fungus-diseases, but also many other insects fall victims to them. In fact, for several years past certain destructive insects have been combated more or less successfully by the artificial propagation and spread of different kinds of these insect-destroying fungi.

At least two, and possibly three distinct species of locust-attacking fungi, have been especially brought before the public in different parts of the world during the past few years. Not that they are the only ones of these plants which select the bodies of acridians as proper places for development, but because they among the others have been most persistent and active in their results.

Not being a specialist in the study of insect-attacking fungi and not having the necessary books of reference before him, the writer is unable to give a satisfactory history of these plants at this time. For the same reason anything like a complete classification is impossible.

The North American Locust-killing Fungus.

The North American locust-killing fungus which has been most noticeable is the one known to botanists as the *Empusa*

grylli. It is the cause of the disease that frequently attacks and destroys myriads of both «native» grasshoppers and the migratory ones. It works best during rather wet, warm weather in midsummer, and seems to attack the mature insects rather than the young ones. At any rate it is much oftener the case that the winged insects are killed by it than are the jumpers.

When an insect has once been attacked by the fungus it becomes rather sluggish in its movements and shortly before death climbs up the stem of some weed or other plant and securely attaches itself by tightly hugging the plant with



Fig. 24. — Locust killed by
Empusa grylli. (After
Lugger).

its front and middle pairs of legs. In this position it dies and remains clinging for some time after death. The bodies of the insects that die from the attacks of this fungus become somewhat swollen and quite soft, and brittle. A few days after death the body dries and cracks open at the joints thereby permitting the brown dust-like spores to escape and be blown about by the winds. Other locusts upon eating vegetation on which such spores may be resting, if the weather and other conditions are favorable, likewise become attacked and die from the disease.

It is most prevalent in the more humid parts of the United States, and also occurs to a considerable extent in the irrigated districts of the arid regions.

Not unfrequently does it happen that the disease becomes so prevalent towards the close of summer that two dozen or more dead locusts may be found clinging to a single small plant. One of these insects as it appears after death, is shown in the accompanying illustration. (See Fig. 24).

The *Empusa grylli* also occurs to some extent in this Republic where locusts killed by it have on two or three different occasions been found and sent to the Commission. Other quarters of the earth are its home also.

The Carcaraña or Argentine Locust Fungus.

Early in his investigations the writer discovered at Carcaraña, in the province of Santa Fé, specimens of full-grown saltos that had apparently died from one of these fungus-diseases. A first glance at the specimens indicated that the fungus which had caused their death was quite distinct from the *Empusa grylli* described above. Having had some experience with a fungus of similar appearance in the destruction of quite another kind of insect in the United States, he suggested that possibly the find was a *Sporotrichum*. To obtain a verification of this surmise, or to learn just where it belonged, specimens of the fungus-killed locusts were sent to Professor Charles E. Bessey of the University of Nebraska, a specialist in this line. He replied that the fungus was without doubt a *Sporotrichum*, but as to the species he could not tell till he had grown it to learn its spore-formation. He also wrote that he considered that a "great find" had been made, and that he hoped experiments would show it to be a valuable locust-destroying medium. No later information concerning the identity of this fungus has been received to date.

Locusts which have been attacked by this native fungus, instead of climbing to the top of various plants so as to get as much open air as possible, creep away from the light and seek for dark, moist places in which to die. Consequently they are most often found hidden away among the roots of bunches of grass, in the midst of dense, juicy foliage, etc. Here, after death,

their bodies become entirely filled with the mycelial threads and spores of the fungus. In many cases, under certain conditions, the spores partially cover the outside of the body also. Several of the insects showing this latter condition are figured herewith. (See Fig. 25, 1, 2, 3, 4, 5, 6.)

In breeding-cage experiments this *Sporotrichum* gave very good results in a number of cases, while on the open camp soon after the arrival of the voladoras from the north many were seen to succumb and turn bright pink. These upon examina-

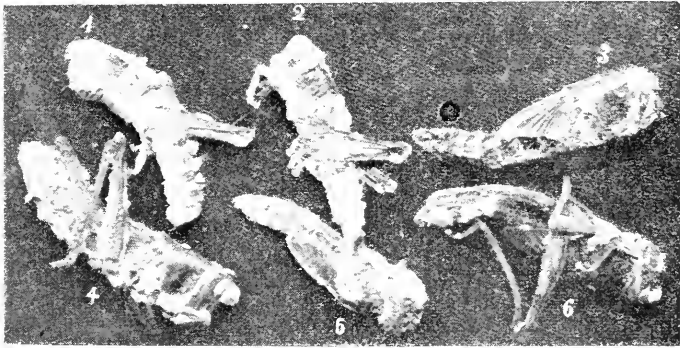


Fig. 25. — Saltonas killed by the Carcaraña locust-fungus. (Original).

tion gave large quantities of the same kind of spores and threads as were found in the fungus-covered saltonas mentioned above. They also imparted the same disease to other locusts when powdered and sprinkled on the food of sound insects.

At present the fungus is working very nicely in the vicinity of Carcarañá, where it has already almost exterminated a good sized manga of the insects. Here a very large supply of the dead bodies of the insects can be obtained with which to spread the disease to other mangas of the voladoras.

The South African Locust Fungus.

Quite early in these investigations specimen-tubes of the South African fungus were obtained and careful experiments were also made on our locust with it. The results obtained,

were less satisfactory, however, than those with the native species. In the breeding-cages, where all conditions were under the control of the experimenter, the locusts exposed died. Outside no such favorable result followed its use.

Just what this African fungus is, has not been determined. It may be, and very likely is, quite another thing from both of the species referred to above.

In the application of these fungus-diseases it must be remembered that each fungus has its peculiar habits, and therefore requires certain conditions for its growth. If a cow or ox be attacked by a disease like "tristeza" it does not necessarily follow that a sheep will also be subject to the same disease, though both are ruminants: just as like as not the South African locust-fungus gave the excellent results on *Pachytylus migratorius*, the most common of the destructive locusts in that region. To expect the fungus to take hold of and kill *Schistocerca paranensis*, which belongs to an entirely distinct sub-family of locusts, is hardly scientific to say the least. That such results might occur is possible but not probable.

If any of these fungi are to be relied upon, why not the native species that is already acclimatized and was discovered as an actual enemy of the very insect whose destruction is sought? Besides, the various species of *Sporotrichum* are recognized by both botanists and entomologists as the easiest of insect-attacking fungi to propagate and to preserve, besides being the most deadly in their effects on the hosts which they attack.

Experiments made during the past spring and early summer tend to show the inefficacy of this mode of locust-fighting to the exclusion of all others. Both at headquarters and at other points in the Republic careful tests were made of the different fungi mentioned, and with practically the same negative results, save where climatic conditions happened to be favorable at the time. But by always keeping a good supply of the fungus-killed locusts on hand and using them where the opportunity occurs and the conditions are favorable much good may and undoubtedly will result.

CHAPTER VIII

“Tucuras” or Non-migratory Locusts.

There are several other locusts, besides the migratory one, which occasionally become sufficiently numerous to injure crops and pastures. These are known by the local name of “tucura” which simply means “grasshopper.” Unlike the *paranensis*, which has been described in the main part of this report, these tucuras are non-migratory. Hence they always remain at the same place year after year, and therefore might be termed “native” grasshoppers or locusts in distinction to “migratory” ones.

These tucuras differ greatly one from the other just as they do from the migratory insect of the country. Some of them are large, others medium-sized, and still others quite small. They likewise differ one from the other in wing-length, in form and in general color. When climatic conditions are favorable to their increase and remain so for two or more years these insects become quite numerous locally. At such times more or less damage is done by them.

Although each region possesses its peculiar species of these tucuras, a few of them are more generally distributed than the others on account of their more hardy nature.

At least eight of these destructive *tucuras* have come to the writer's notice during the comparatively short time spent here in the Republic. No doubt there are others also which should be included among these occasionally destructive locusts. In fact, it would be well to at least list all of the members of the locust-family which are to be found in the country,

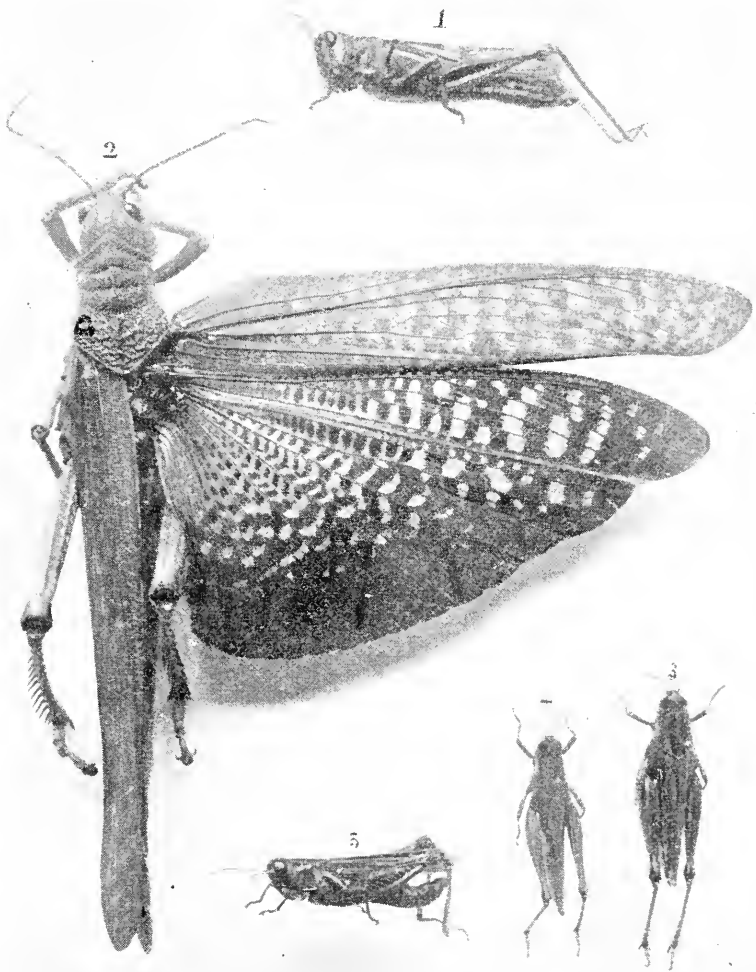


Fig. 26. — 1, short-winged Schist. parnense; 2, *Tropidacris cristatus*; 3, *D. chroplus*-sp; 4, do; 5, do; Natural Size. (Original).

if not to enter more fully into a discussion of their distribution, food-habits and life-histories. To do this would, however, require more time and space than are at our disposal just at present. Already there are more than one hundred distinct species of these insects known to exist, and careful collecting would undoubtedly add as many more.

Next to the destructive or migratory species, on account of its great size and powers for flight, should be mentioned the "Langosta Negra" (*Tropidacris cristata* Linn.). This insect although principally a tropical species is found in small numbers in several of the mountain-provinces. It usually lives in wooded districts where it feeds upon the leaves of trees and shrubs. Being a good flier it sometimes joins *paranensis* when mangas of the latter fly by. Hence the occasional reports which circulate to the effect that locust-mangas are led by kings or queens. While very large, this insect is exceeded in size by a couple of other species of this and an allied genus which are also natives of tropical America. They never appear in numbers sufficient to cause much damage.

The large, green, short-winged locust shown at fig. 3, on plate 27 is known by the name *Elæochlora viridicata* Serv. It sometimes, as reports say, becomes quite abundant on the camps of several of the pampa provinces where it eats the grasses. The male insect differs from his mate in being very much smaller and in having fully developed wings (See plate 27, fig. 6). Not long since a female was captured and 156 fully developed eggs taken from her body.

Several of the smaller insects figured in the accompanying plates also increase so as to do harm to camps. These are members of the genera *Dichroplus* and *Paradichroplus*.

The insect figured at 2 on plate 27 is inclined to migrate at times. It is also quite abundant all over the Republic north of Bahia Blanca. In color it is green with red spots and bands on head and legs. Its hind wings are delicate blue. The name by which it is known to entomologists is *Zoniopoda tarsata*.

Still other locusts like those shown at 1, 4, 5, in Fig. 27 are sometimes among the injurious kinds. The *Rhomalea stollii* is interesting because of the habits possessed by the saltonas. They invariably go in droves or herds varying in number from a couple of dozen to several thousands. They are also very conspicuous, being shining-black marked with red spots and bands. The voladoras also retain the social habit to a

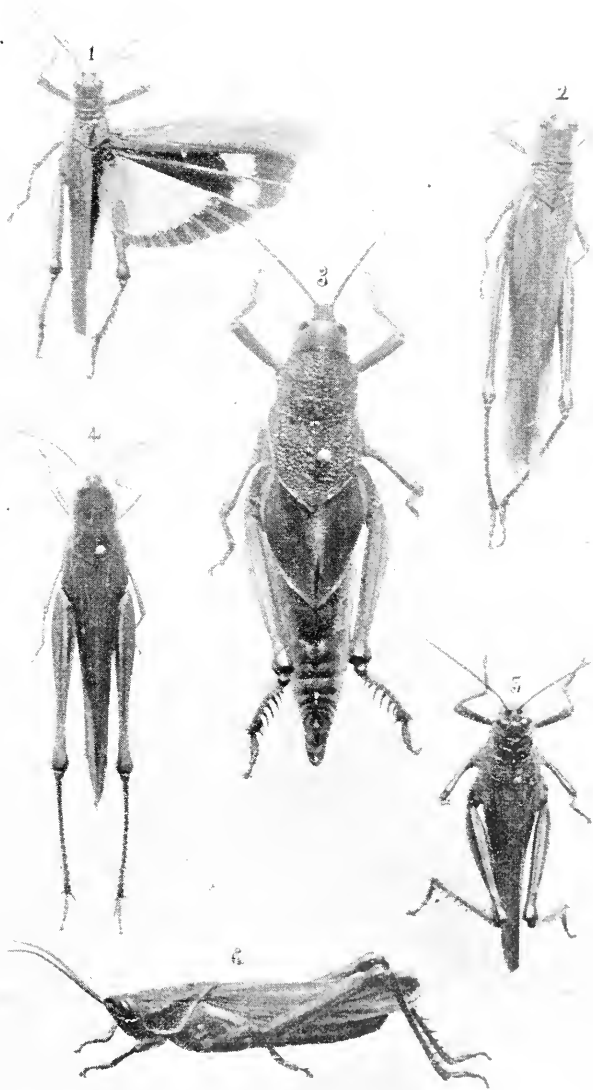


Fig. 27.—Various species of native locusts or tucuras. Natural size. (Original.)

greater or less degree. After wings are obtained the insects become olive-green, with the under wings bright red and black. The male is shown at 1, Fig. 27 with the wings of one side spread, while the female can be seen by referring to 5 of the same plate.

These tucuras can be fought by similar methods as those described in connection with *parancensis*.

CHAPTER IX

Summary.

We have ascertained that the destructive locust of the Argentine Republic is distinct from both the North American and Old World species, as well as from two or three other closely allied forms found in tropical and sub-tropical America. That it winters as a voladora in the vicinity of the 30th degree of south latitude; and also that the freshly winged, the wintering, and the egg-laying insects can each be recognized by their prevailing colors. In other words, these three stages in the insect's career are to be known by special color-characteristics. We have ascertained, or believe we have, that the insects which obtain their wings in January do not lay till September or October; that normally it is but single-brooded, and that only one *cartucho* of eggs is laid by each female. Our data seem also to show a return to the north for wintering of all insects reared southward of the 30th degree of latitude. It has been ascertained that this locust is a poor hopper, but an excellent flier. Nevertheless it is one of the easiest of all destructive locusts to fight on account of its habits of always bunching. A very important and useful fungus-disease of the insect has been found, and tested with good results when climatic conditions were favorable. Various methods of warfare have been tried and found to be practical; and it has been ascertained that the Argentine locust has many natural enemies which if encouraged will by themselves keep it within bounds only in exceptional cases.

The Government Central Commission is to be congratulated

on the excellent work of extinction which it has accomplished during the year. The destruction of eggs, voladoras and saltonas has been immense. That this work has been effective there can be no doubt whatever, although the insect is by no means reduced to harmless numbers.

Even now there do not appear to be many more locusts in the country than there were in the spring when egg-laying had just begun. This being true, we can take courage since there is a long time between the present and egg-laying next spring. The individual locusts now alive have many risks to run. Their numbers will be continually diminished by various accidents each day between now and when their invasions begin next spring. All the agencies mentioned in the chapters on "natural enemies" and "fungus-diseases" will combine to bring this about. Then too, artificial means can be made to greatly assist in bringing about this reduction in their numbers. Surely the pest is on the decline! Therefore every body in the country should take courage and strike vigorously so as to hasten the complete downfall of the enemy. When this shall have been accomplished, the danger for the future from this source will be comparatively easy to regulate. This may be done by the appointment of a suitable person to watch the movements of the insect and to cause the destruction of any small beginnings of destructive mangas.

Recommendations.

If it be permissible for a foreigner to make suggestions the writer would like to recommend, in the first place, the appointment of a competent Government Entomologist to have charge of all questions relating to insect-pests of whatsoever description. This officer could be connected with the National Department of Agriculture, as in Australia, New Zealand and other countries where entomologists are employed.

Laws relative to the control of both insect and weed-pests, if not too rigid, are excellent. Of course it is evident that both weeds and insects are detrimental to growing crops and therefore should be destroyed. A careless person may unwittingly not only allow his own crops to perish, but also be the cause of injury to those of his more careful neighbor. In such cases a little interference by the law may remedy matters.

Knowing the great value of birds as destroyers of injurious insects, the writer would also recommend the protection of *all kinds of birds* for a term of not less than three years. It would also be well to teach the public the great value of such harmless animals as lizards, frogs and toads, so that we may

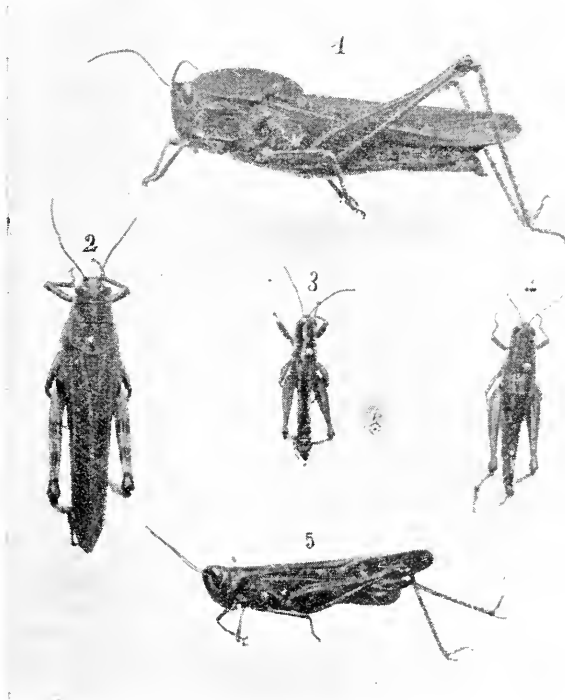


Fig. 28. — Various species of native locusts or tucuras. (Original).

be the better aided in our war of destruction which it is necessary to wage against all insect-pests.

Although the experiments with locust-killing fungi have proven the uselessness of them as a sole means of destroying the locust-pest, it is recommended that a sufficient supply of the *Sporotrichum* or Carcarañá Locust Fungus be kept on hand,

to use against it when conditions are favorable and necessity demands it.

Allow also the assertion to be made here that no one remedy — disease or mechanical, natural or artificial — can be recommended to the exclusion of all others when it comes to dealing with so formidable a pest as is *Schistocerca paranensis*.

Conclusion.

In conclusion the writer would suggest that these studies, which have already resulted in the accumulation of many very interesting facts in the life-history, habits and distribution of our locust, be continued.

There still remain some important facts connected with the insect's life which should be definitely settled before reliable predictions can be made relative to future movements and possible injuries. Some of these are connected with its movements, wintering, egg-laying, possible permanent-region, distribution, etc. Many of these facts can be obtained by the accumulation of reports from volunteer-observers located throughout the regions at times visited by the moving mangas of locusts. These reports can be sent to some central point, and the facts there tabulated to be studied later.

The knowledge now possessed roughly indicates what may be looked for later, but is still indefinite on a few important points in the insect's life-history.

APPENDIX

Report of Sub-Commission.

Carcaraña (F. C. C. A., 22 February 1898,
Provincia de Santa-Fé).

*J. F. Roberts, Esq., President of the "Comision Investigadora
de la Langosta."*

Buenos Aires.

Dear Sir: —

In submitting the list of names of those who have favored us with Reports on the date of arrival and subsequent movements of the "mangas" of locusts, and of depositing and hatching of eggs, etc., the sub-commission desire to acknowledge the industry, zeal, and intelligence with which many of the reports were prepared, and to return their thanks to all for their valuable contributions to this preparatory study of the locust-problem.

The station-masters of the Railways of the republic are also entitled to the thanks of the sub-commission for the regular transmission of telegraphic reports of the movements of the locusts and forwarding of specimen-insects during the present invasion of the common enemy.

Very Truly Yours.

*Oliver C. James, Henry B. Coffin,
Charles R. Kenyon, Walter G. Davis,*
Sub-Commission of Statistics.

List of names.

Agüero, M.....	Fortín Averías, F. C. C. N.
Akemeier, Alberto.....	Tinogasta, Catamarca.
Ahrens, Guillermo.....	Cervecería San Vicente, Córdoba.
Aldao, O. de.....	Florida, F. C. C. U.
Almozara, L.....	Santa Lucía, F. C. C. U.
Alvarado, Silvestre.....	Pocito, San Juan.
Alvarez, B. M.....	Sarmiento, Tucumán.
Amaya, C. R.....	Irigoyen, F. C. R.
Amy, E. F.....	Moreno, Buenos Aires.
Anderson, George.....	San Genaro, F. C. C. y R.
Anderson, J.....	Venado Tuerto, F.C.S.S.F. y Córd.
Arnedo, Pacífico.....	Caldera, Salta.
Arramayo, Francke & C. ^a .	Tupiza, Bolivia.
Baines, R. C.....	San Nicolás, F. C. C. A.
Baendel, Gustavo.....	Barrancas, Corrientes.
Baker, J. B.....	Córdoba.
Barclay, D. Hay.....	Guaminí, Buenos Aires.
Baker, A. C.....	Tala, Entre Ríos.
Barnett, W.....	Soldini, F. C. C. A.
Barr, Guillermo J.....	Rosario, Santa Fé
Barrow, F. W.....	Administración F. C. del Sud.
Barry, J. C.....	Luxardo, F. C. B. A. y R.
Benny, Lorenzo.....	Alberti, F. C. O.
Bertuzzi, Celso.....	López, F. C. B. A. y R.
Bell, Geo.....	Maggiolo, F. C. S. S. F. y Córdoba.
Becker, F. G.....	Arrecifes, Buenos Aires.
Bernard, B. M. & C. ^a	Gilbert, F. C. C. E. R.
Beckers, Lorenzo.....	Santa Ana, Entre Ríos.
Berwyn, R. J.....	Rawson. Chubut.
Behr, Hans von.....	Colonia Dalmacia, Chaco.
Benitz, Alfredo.....	Calchaquí, F. C. á Reconquista.
Bigót, Graciano.....	Alcorta, F. C. Uruguayo.
Biverly.....	Mendoza.
Blanco, C. C.....	Cerro Colorado.
Blamey, Joel.....	Huasán, Adalgalá, Catamarca.
Borrmann, Federico.....	Col. Sorita, Manl. Gálvez, Santa Fe.
Bousquet, J.....	Merlo, Buenos Aires.
Boutard, L. E.....	San Nicolás, F. C. C. A.

Branner, Dr. J. C.	Leland Stanford Uni., Cal., U.S.A.
Brown, W. R.	Susana, Santa Fe.
Brüning, Santiago.....	Armstrong, F. C. C. A.
Bridger, Robert.....	Merinos, F. C. Montevideoano.
Branciforti, P. de Leonforte	Candelaria, F. C. C. A.
Breveglieri, José.....	Col. Gral. Roca. Sanford, Santa Fé.
Braga, Eduardo	Porvenir. Uruguay.
Bross, V.....	Helvecia. Santa Fé.
Bredereck, Carlos.....	Concordia.
Bury, Oliver R. H.....	Paraná, Entre Ríos.
Burklin, S.....	Felicia, Santa Fé
Burger, Antonio.....	Benítez, Resistencia, Chaco.
Bustamante, Genaro	Tumbayo. Jujuy.
Casey, Santiago.....	Rawson, F. C. al Pacífico.
Casanova, J.....	San Fernando, F. C. C. A.
Carpenter, Geo.....	Las Rosas, F. C. C. A.
Campagno, E.	Conesa, F. C. C. A.
Cardoso, Enrique.....	Armstrong, F. C. C. y R.
Carbaccio, A.....	Tala, F. C. C. N.
Cabirol, Carlos P.....	Cobos, Salta.
Carballo, E.....	Cabal, F. C. S. F.
Casali, Fray Cornelio	Corrientes.
Caranti, Francisco	Corrientes.
Capot, J.....	General Iriarte.
Capelli, Fray Emiliano....	Resistencia.
Cilley, J. J.	San Isidro, Buenos Aires.
Claus, Cristian.....	Colonia Progreso. Santa Fe.
Clark, John E.....	San Isidro, Buenos Aires.
Clarke, J. Percy.....	Ing ^o F. C. B. A. y R., Buenos Aires.
Cook, Alfredo B.....	Fisherton, F. C. C. A.
Coria, B.	La Francia, F. C. C. C.
Creaghe, Esteban B. Dr....	Luján.
Cumming, A.....	Insp. Tráf. F.C.B.A. y R., Bs. Aires.
Daltoso, A.....	Manuel Ocampo, Santa Fe.
Daniell, Thos. Cecil.....	Villa Formosa, Chaco.
Davies, R. A.....	Trelew, Chubut.
Davis, W. G.....	Córdoba, Oficina Meteorológica.
Darbyshire, Henry.....	San Julian, F. C. C. de E. R.
Depaoli, C. S.....	Sunchales, F. C. B. A. y R.
Denner, Santiago	Esperanza, F. C. P. S. F.
Destefanis, Enrique.....	Arequito. F. C. O. S.
Deluchi, Domingo.....	José Mármol, Buenos Aires.

Derby, Dr. O. A.....	São Paulo, Brazil.
Descalzo, Santiago.....	Washington. F. C. Pacífico.
Dillon, Santiago S.....	Cuartel 8.º, Navarro, Buenos Aires
Dietrich, Fr.....	Azul, F. C. S.
Dieckmann, Daniel.....	Mar del Plata, Buenos Aires.
Díaz, Liborio.....	Sedantas.
Doutrelepont, C.....	General Pinto, Buenos Aires.
Douglas, A. G.....	Arroyo Grande, Concordia, E. R.
Donney, Roberto.....	Villafañe, Bragado, Buenos Aires.
Domínguez, José G.....	Paso de los Toros, Uruguay.
Drewsen, C.....	Sastre, F. C. C. y R.
Duranti, Valerio.....	Carnerillo, F. C. N. A.
Drysdale, Juan.....	Buenos Aires.
Duarte, Feliciano.....	Paso de los Libres, Alto Uruguay.
Eguren, Agustín.....	Buenos Aires.
England, Geo.....	Cruz Chica, F. C. C. y N. O.
Engel, Ricardo.....	Villa Urquiza, Entre Ríos.
Estela, Antonio.....	Minas, F. C. C., Uruguay.
Ezcurra, Pedro.....	Morón, Buenos Aires.
Fanmen, J.....	Rosario de Tala, Entre Ríos.
Faust, Juan.....	Col. Nueva Alem., Villaguay, E. R.
Falmöl, Chr.....	Venado Tuerto, F. C. S. S. F. y C.
Falzotti, L.....	Quegay, Uruguay.
Fehrmann, D. & C. ^{ta}	Bahía Blanca.
Fernández, J.....	Merinos, Uruguay.
Fitz Herbert, Arthur V. . .	Mercedes, Uruguay.
Figueroa, Eudoro.....	San Bdo. de Diaz, Salta.
Flagg, Dr. E. M.....	Asunción, Paraguay.
Flores, Justo P.....	Rodeo del Medio, Mendoza.
Forget, Alfred E.....	Federación, E. Ríos.
Fouilliand, F.....	Posadas, Misiones.
Fraser, H. W.....	Bragado, F. C. O.
Fraser, Juan.....	Carlos Casares, F. C. O.
Franchini.....	Ataliva, F. C. P. S. F.
Frers, Juan.....	Azul, Bs. Aires.
Frundale, Arthur W.....	Parish, F. C. S.
Fürth, Wolf von.....	V. Urquiza, E. Ríos.
Gandolfo, Domingo.....	Chivilcoy, Bs. Aires.
Garramandy, D. Cuyás....	Yerúa, E. Ríos.
Galvan, E. J.....	O'Higgins, F. C. P.
Gerlino, Stefan.....	Eldorado, Depto. Unión. Concordia.
Gibson, Herbert.....	Gral. Lavalle, Bs. Aires.

Gietz, Adolfo.....	Sunchales, F. C. B. A. y R.
Gibbins, Diego.....	Gral. Paz, F. C. S.
Gomez de Teran, L.....	San Juan, Escuela Nacl. de Minas
Gomila, Teófilo C.....	Tres Arroyos, Bs. Aires
Gostling, A. C.....	Villa Constitución, Sta. Fé.
Griswold, F. L.....	Rioja.
Greene, Juan.....	Vedia, F. C. P.
Green, Roberto.....	Zárate, Bs. Aires.
Grün, Friedrich.....	Col. Meron, Espinillos, Córdoba.
Groeziuger, Hnos.....	Col. Belgrano, Wildermuth, Sta. Fé
Greenslade, P. S.....	Rosario, Santa Fé.
Grieve, Robt. J.....	Bahía Blanca.
Guzmán, Cecilio.....	Valle Grande, Jujuy.
Gubba, A.....	Buenos Aires.
Gutiérrez, M.....	Traill, F. C. C. y R.
Harrington, Dr. D.....	Arrecifes. Buenos Aires.
Haimés Hnos.....	Concepción, Tucuman.
Haddock, E. J.....	Washington, F. C. P.
Harrison, S. S.....	Halsey, F. C. O.
Hasenkamp.....	Antonio Tomás, E. Rios.
Herrmann, Jorge C.....	Río Segundo, F. C. C. A.
Hearne Michael.....	Los Barriles, Colón, Buenos Aires.
Holland, A. H.....	Halsey, F. C. O.
Hope, Gmo.....	Col. Alejandra, Sta. Fé.
Hope, Roberto.....	San Gerónimo. F. C. C. A.
Hobecker, George.....	Florencia Norte, Chaco.
Humphrey, Mauricio.....	Rawson, Chubut.
Hughes, W. M.....	Trelew, Chubut.
Istilart, Juan B.....	Tres Arroyos, Buenos Aires.
James, Fred.....	Arroyo Corto, F. C. S.
James, H. J.....	Los Toldos, Bs. Aires.
Jaeschke, Victor Julio....	Buenos Aires.
Jewsbury, H.....	Gualeguay. E. Rios.
Jewish Colonization Asso- ciation.....	Col. Clara, Dominguez, Villaguay.
Jewell, Cárlos.....	San Jorge, F. C. C. A.
Jough, H. de.....	Friondo, F. C. P. S. F.
Kenyon, Charles R.....	El Paraiso, F. C. B. A. y R.
Kern, Jacob.....	Irigoyen. F. C. B. A. y R.
Kehoe, Dr.....	Rosario Sta. Fé,
Key, Diego.....	Gualeguaychú. E. Rios.
Kitt, Roberto.....	Coronel Dorrego, F. C. S.

Klaus Hermann.....	Carolina, Depto. Pringles, S. Luis.
Knowles, William.....	Villa María, F. C. C. A.
Korhr, Federico.....	Las Palmas, Chaco.
Krabbe, C. H.....	Buenos Aires.
Kriebaum, Cárlos.....	Rosario, Santa Fé.
Kuriguer, Antonio.....	Carcarañá, F. C. C. A.
Larden, Enrique N.....	San Urbano, F. C. S. S. F. y C.
La Fone - Quevedo, S. A.	Pilciao, Andalgalá, Catamarca.
Lamoureux, A. J.....	Rio de Janeiro.
Lang, Teodoro.....	San Francisco, Córdoba.
Lawrie, T. Dick.....	La Carlota, F. C. S. S. F. y C.
Las Palmas Produce C.º..	Las Palmas, Zárate.
Lesueur, A. W.....	San Cristóbal, Santa Fé.
Lett, Richard E.....	Arroyo Corto, F. C. S.
Lemos, Lucas.....	Valle Grande, Jujuy.
Lett, Hugo D.....	Rojo, F. C. C. A.
Lodi, Domingo R.....	Arteaga, Santa Fé.
Lopez, Dámaso.....	Perico San Ant.º, Potrerillo, Jujuy.
Lopez, M.....	Mercedes, Buenos Aires.
Lopez, Desiderio.....	La Reduccion, Jujuy.
Lopez, R. V.....	Tucuman.
Lopez del Frade, A.....	San Carlos, Salta.
Lowe, Luis J.....	Drabble, F. C. O.
Lowe, Nicolas.....	Mercedes, Buenos Aires.
Lucero, Emilio.....	San José, F. C. C. C., seccion C. N.
Lyall, Douglas.....	Garruchos, Alto Uruguay.
Lyon, J. D.....	General Villegas, F. C. O.
Mac Donnell, F. J.....	Chivilcoy, F. C. O.
Mac Dougall, Geo.....	Nogoyá, Entre Ríos.
Mac Allister, J.....	Inspector tráfico, F. C. B. A. y R.
Mac Rae, Donaldó.....	Los Corrales, Pilar, Santa Fé.
Martin, J.....	Zavalla, F. C. O. S. F.
Maldonado, J.....	Fuentes, Depart. Caseros, Sta. Fé.
Mariani, Enrique S.....	Molinos, Salta.
Maris, Víctor.....	Colonia Popular, Chaco.
Matthes, Carlos.....	Tornquist, F. C. S.
Max, F. W.....	Bahía Blanca.
Meyer, D. y Cia.....	Bahía Blanca.
Meyer, Claudio.....	Olavarria, Buenos Aires.
Mendieta, La.....	Ing.ª, Perico, Jujuy.
Merkwitz, H.....	Bergara, Villaguay, Entre Ríos.
Merlo, Juan.....	Maipú, Buenos Aires.

Metting, A.....	Potosí, Bolivia.
Miles, William	Gualeguay, Entre Rios.
Miranda, Juan A.....	Rinconada, Jujuy.
Mooney, G. M.....	Viña, F. C. C. A.
Monti, Francisco	Frias, F. C. C. C.
Morkill, W. L.....	Administracion F. C. O. S., Rosario.
Mulleady, Tomás.....	La Irma, via Choele-Choel.
Müller, Carlos.....	Esperanza, F. C. P. S. F.
Muggeridge, A. L.....	Sauce Corto, F. C. S.
Murchio, L.....	Halsey, F. C. O.
Muñoz, José E.....	General Frias, Salta.
Mulhall, W. F.....	Buenos Aires.
Murphy, G. J.....	Baradero, Buenos Aires.
Nancamo, J.....	Alta Gracia, F. C. C. A.
Novilla, H. de.....	Joaquina, F. C. P. S. F.
Oberlin, J. B.....	Diamante, Entre Rios.
Onagoity, Juan F.....	9 de Julio, Rio Negro.
O'Dwyer, Juan.....	Galarza, F. C. C. E. R.
Ortiz, José D.....	Perico del Carmen, Jujuy.
Ortiz, Emilio D.....	La Yerba, San Jorge, F. C. C. A.
Ortiz, Pablo.....	La Cautiva, F. C. Pacífico
Ostendorf, Luis.....	Paraná, Entre Rios.
Owen y Dodington	Centeno, F. C. C. y R.
Page, Felipe.....	Estancia Rabon, Entre Rios.
Paz, Victoriano L.....	Capilla del Monte, Córdoba.
Pauletti, Ernesto E.....	Piedras Coloradas, Uruguay.
Passicot, Juan.....	Buenos Aires.
Payne, Will	Córdoba.
Pearse, Harry	Campana, F. C. R.
Peyrotti, Luis.....	Agua Sucia, Depart. Anta, Salta.
Pearl, Dr. Enrique	Venado Tuerto, F. C. S. S. F. y C.
Petersen, Otto.....	Trenque Lauquen, Buenos Aires.
Perez, Benigno.....	Suipacha, Buenos Aires.
Petty, Henry J.....	Cañada de Gomez, F. C. C. A.
Pilcher, Jorge B.....	Jesús María, F. C. C. C.
Pommerenke, G.	Rosario, Santa Fé.
Plate, Henri E.	Asuncion, Paraguay.
Polo, Tito.....	Peyrano, F. C. C. A.
Portiglia.....	Cuartel 8.º, Alberti, Buenos Aires.
Pritchard, F. G.....	Colonia, Chubut.
Quiroga, Bailon	La Paz, Mendoza.
Rapelli, Luis	Administr. F. C. C. N., Tucuman.

Ramos, Fructuoso.....	Colquechaca, Potosí, Bolivia.
Ré. Félix	Ceres, Santa Fé.
Rector, Thomas G.....	Córdoba.
Reed, Edwin C.....	Rancagua, Chile.
Reil, Patricio	Capilla del Señor, Buenos Aires.
Richards, S. & Whiting....	Vera, Santa Fé.
Ricketts W. Vincent.....	Nueva Palmira, Uruguay.
Riedel, Luis.....	Galarza, E. Ríos.
Rivero, J. C.....	Bragado, F. C. O.
Rieve, A.	Gral. Villegas, Bs. Aires.
Riedel, Augusto.....	Bergara, Villaguay, E. Ríos.
Ricketts, Theo. J.....	Margarita, F. C. á Reconquista.
Rinaldi	La Francia, F. C. C. C.
Rigby, Jason.....	Administración F. C. B. A. y R.
Ripamonti, Hnos.....	Rafaela, Santa Fé.
Rodríguez, Ramón S.....	Gob. Basavilbaso. E. Ríos.
Rojas, M. A.....	La Plata.
Rodríguez, Nicanor E.....	Yaví, Jujuy.
Rose Hermann.....	San Gustavo, E. Ríos.
Roskell, Augustine J.....	Bell Ville.
Rufino, Bernabé.....	Piquete, Depart. Anto. Salta.
Salto, S.....	Recreo, F. C. C. C.
Sanintoyos.....	Patagones, Bs. Aires.
Salas, Emiliano.....	Tilcara, Jujuy.
Sánchez, P.....	Cruz del Eje, Córdoba.
Sanabria, Angel.....	Passo. F. C. á Trenque Lauquen.
Sassenberg, J. A.....	Viedma, Río Negro.
Salguero, J. Belisario.....	Perico del Carmen, Jujuy.
Schaefer, Federico.....	Catamarca.
Schaffters, Margarita B. de.	Villa Hernandarias.
Schiele, Eduardo C.....	San Gustavo, E. Ríos.
Schimield, Rev. W. H.....	Fray Bentos.
Schmidt, Dr. M.	Andalgalá, Catamarca.
Schmidt, Ernesto.....	Villa Encarnación, Paraguay.
Schnaith, Federico.....	San Martín, Mendoza.
Schneider, Julio.....	Federación, E. Ríos.
Schunk, Ricardo.....	San José, F. C. C. Uruguayo.
Schulte, Santiago.....	Colonia Nueva, Humboldt, Santa Fé.
Schulz, Federico.....	Córdoba.
Schulz, J. F.....	Col. Nueva Alemania, Villaguay. E. Ríos.

Schuppff, Padre Ambrosio.	Porto Alegre, Brasil.
Schwartz, E.	Rivadavia, Salta.
Scriza, Vieira E. de.	San Pedro, F. C. C. C.
Sinn, Enrique.	Felicia, Prov. Santa Fé
Silva, M.	Cuartel 8.º, Alberti, Bs. Aires.
Smith, Carlos.	Tucumán.
Smith, Alexander.	Ingeniero, Secc. IV, F. C. B. A. y R.
Smellie, H.	La Blanqueada, Concordia, E. Ríos.
Socin, Emil.	Colonia Ataliva, Santa Fé.
Solari, P.	Cuartel 8.º, Alberti, Bs. Aires.
Soler, Alberto.	Ingeniero, Secc. II, F. C. B. A. y R.
Spilsbury, Gybbon, Rev. Dr	Concepción del Uruguay.
Sparks, V. O.	General Iriarte, F. C. al Pacífico.
Spies, Felipe.	Felicia, Santa Fé.
Spies, Johannes.	Esperanza, Santa Fé.
Stellmacher, Carlos.	Monte Caseros, Concordia.
Steigleder, Christian.	Sunchales, Santa Fé.
Stempelmann, Dr. Hugo. .	Rosario, Santa Fé.
Stukemberg, A.	Hersilia, F. C. B. A. y R.
Suarez, Manuel.	Rosario, Santa Fé.
Suhr, Eduard.	Arias, F. C. S. S. F. y C.
Suter, Carlos.	Colonia Bauer y Sigel, Santa Fé.
Sword Hnos.	Zavalla, F. C. O. S.
Tapper, Juan W.	Marcos Juarez.
Terizaghi, Pablo.	Perez, Santa Fé.
Tetley, Francisco.	General Paz, F. C. S.
Thering, Dr. A. von.	São Paulo, Brasil.
Thomas, William T.	Carcarañá, F. C. C. A.
Thomas, Oliver W.	Carcarañá, F. C. C. A.
Thaw, Arturo E.	Estancia Rabon, Entre Ríos.
Tetley, Cadwalader, J.	Halsey, F. C. O.
Theilig, Carlos.	Col. Rodriguez, Bell Ville, F. C. C. A.
Thoss, R.	Roldan, F. C. C. A.
Thorning, J. Jorge.	Canals, F. C. S. S. F. y C.
Toohy, M.	Cacequi, Brasil.
Torrica, Antonio.	Tilcara, Jujuy.
Touilland, Francisco.	Posadas, Misiones.
Traileer, E.	Paysandú, Entre Ríos.
Treloar, W. A.	Chilecito, Rioja.
Turner, E. D.	Chajarí, Entre Ríos.
Turnbull, Jas. R.	Arroyo Corto, Buenos Aires.
Vaccarezza, A.	Cuartel 8.º, Alberti. Buenos Aires.

Velcich, Antonio.....	Iturraspe, F. C. B. A. y R.
Velardes, Moisés J.....	Alto Verde, Mendoza.
Vera, M.....	Yaví, Jujuy.
Vera, A.....	Florencia, Chaco.
Vergara, M. V.....	Cosquin, F. C. C. C.
Villagran, Francisco M....	Gunchipas, Salta.
Villalonga, H.....	Administr. F. C. G. O. A., Mendoza.
Viellarruel, D.....	Los Cardos, F. C. C. A.
Vionnet Hnos.....	Pilar, Santa Fé.
Wagner, Dr. Federico	Paraná, Entre Ríos.
Warren, William.....	Administr. F.C. Midland, Uruguay.
Watson, Jas.....	Santa Eufemia, F. C. V. M. á Ruf.
Whitney, H. S.....	Paracis Mountains, Brazil.
Weihmüller, G.....	San Gerónimo, F. C. C. A.
Werner & C. ^a	Villa Casilda, F. C. O. S.
Wesley, E.....	Gualeguaychú, Entre Ríos.
Wilford, E. H.....	General Villegas, F. C. O.
Williams, E. J.....	F. C. C. del Chubut.
Wentworth Cumming, C.	Montevideo.
Woodward, N. B.....	El Trébol, F. C. C. A.
Woolmer, Andrew C.....	Concordia, Entre Ríos.
Young, R. A.....	Las Palmas Chaco.
Zabalza, D. Javier.. ..	Villa Casilda, F. C. O. S. F.

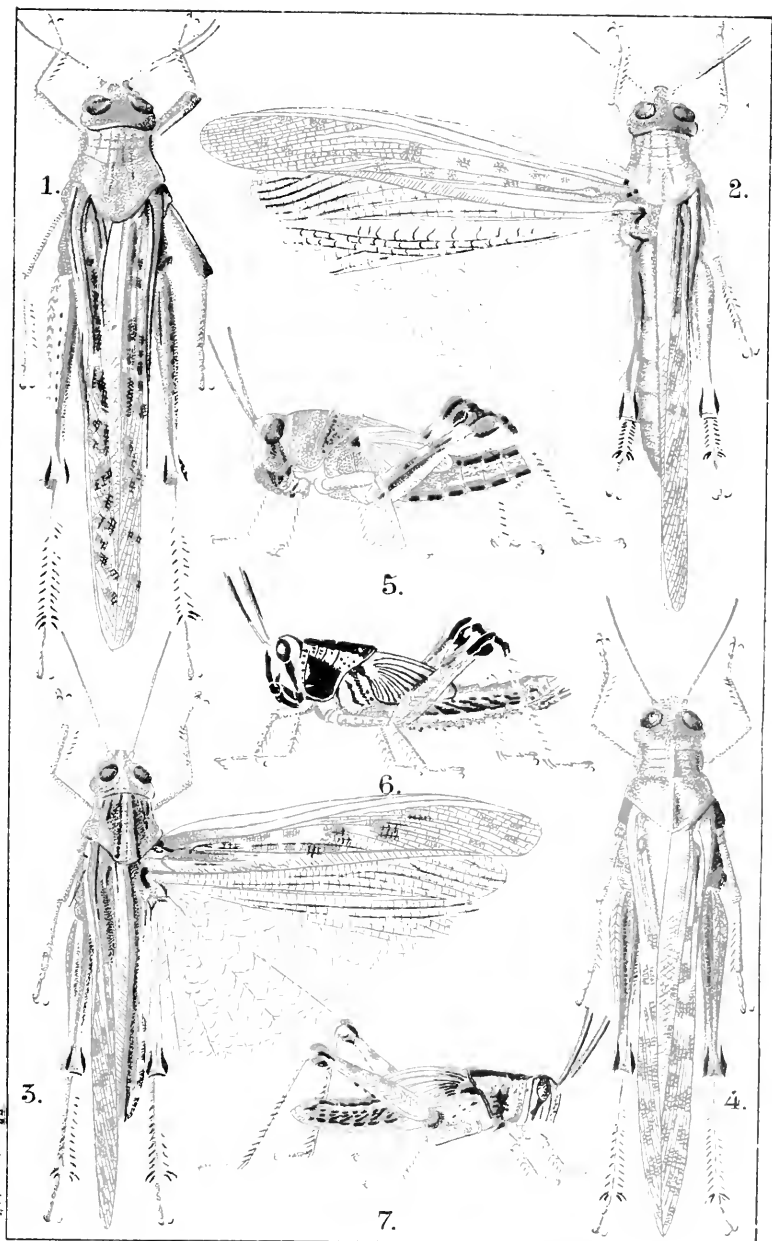
INDEX

Locust Investigation Commission.....	III
Letter of submittal.....	VI
Introduction	IX
CHAPTER I.—Classification.....	1
• II.—Description	4
• III.—Life history,—Habits.....	13
• IV.—Reasons for the excessive increase of destructive locusts...	33
• V.—Remedies.—Natural.....	37
• VI.—Artificial Remedies.....	59
• VII.—Locust killing Fungi.....	75
• VIII.—«Tucurass or Non-migratory Locusts.....	80
• IX.—Summary.....	85
APPENDIX.—Report of Sub-Commission.....	89

Explanation of Colored Plate.

- Fig. 1 — *Schist. paranensis* (Burm.); female, in spring or breeding color.
- Fig. 2 — *Schist. paranensis* (Burm.); female, in wintering color.
- Fig. 3 — *Schist. paranensis* (Burm.); male, color of newly winged specimen.
- Fig. 4 — *Schist. peregrina* (Linn.); female, of Algerian or Old World locust, normal color.
- Fig. 5 — *Schist. peregrina* (Linn.); full-grown « saltona » or nymph.
- Fig. 6 — *Schist. paranensis* (Burm.); full-grown « saltona » or nymph.
- Fig. 7 — *Schist. americana* (Drury); full-grown « saltona » or nymph.

Drawn on stone and colored from original specimens by Federico Burmeister, of the «Museo Nacional», Buenos Aires, Argentine Republic, S. A.



F. Bonander pinx. - A.

1. *Sch. paranensis*
 2. *Sch. paranensis*
 3. *Sch. paranensis*

4. *Sch. peregrina*
 5. *Sch. peregrina*
 6. *Sch. paranensis*

7. *Sch. americana*

ERRATA

Page 24 line 8 instead of « wings » read « thighs ».

- » 31 » 34 » » « seen » » « seem ».
- » 39 » 1 omit note of interrogation after « acrydii ».
- » 45 » 6 instead of « is has » read « it has ».
- » 47 » 13 » » « nemora » » « nemorea ».
- » 47 » 14 » » « Weyenburg » » « Weyenbergh ».
- » 53 » 28 » » « locusts-warms » » « locust swarms ».
- » 63 » 23 » » « posioning » » « poisoning ».
- » 81 » » » « paranense » » « paranensis ».
- » 81 » 6 » » « methods » » « method ».
- » 88 » 21 » » « possesed » » « possessed ».

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 00074 7345