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VIII.

ENTOMOLOGICAL RESULTS (7).

SCHISTOCERCA, SPHINGONOTUS AND HALMENUS.

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INTRODUCTION.

THE collection on which this paper is based consists of 176 specimens of *Schistocerca*, 124 specimens of *Sphingonotus*, and 17 specimens of *Halmenus*. Nearly all of these specimens were killed in cyanide of potassium and are preserved on pins. The paper was prepared under the supervision of Professor Vernon L. Kellogg in the entomological laboratory at Stanford University.

Only one Galapagos species of *Sphingonotus* has hitherto been described. This is *S. fusco-irroratus* of Stål, who says

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that it occurs also on the island of Puná near Guayaquil, Ecuador. Likewise, only one species of *Halmenus*, *H. robustus* Scudder, has heretofore been recorded. The material here reported on, however, shows that there are on the Galapagos at least two species including seven races of *Sphingonotus*, and three if not four species of *Halmenus*.

Genus Schistocerca.

GENERAL REMARKS.

Two Galapagos species of Schistocerca have been described, viz. S. melanocera (Stål) and S. literosa (Walker). In neither case is it recorded from which island the type came, but all subsequent researches have shown that S. melanocera occurs on Charles, Barrington, Indefatigable, Jervis, James, Albemarle and Narboro, and that S. literosa occurs on Chatham, Hood and Tower. Scudder reports that one female of S. melanocera was collected on Chatham by Baur, and Butler accredits two specimens of S. literosa, collected by Darwin, to Charles Island. It is doubtful, however, whether both forms ever occur normally on the same island. It is well known that Darwin did not always keep his specimens from the various islands well separated. We saw neither S. melanocera on Chatham nor S. literosa on Charles, but in each case found the other species very abundant.

Both Wolf and Agassiz have stated that S. melanocera inhabits only the higher parts of the islands and S. literosa the lower. My own observations are wholly at variance with these statements. In both December and June S. melanocera was found in enormous numbers along the very edge of the shore at Iguana Cove, Albemarle, and was common up to 1,000 feet. Above this almost none were seen. The same was true at Tagus Cove, Albemarle. The grasshoppers were everywhere numerous on the low hills about the cove and at the base of the mountain two miles inland. On the sides of this mountain they were scarce, but a few were found all the way to the top, 4,000 feet. On Charles Island during May the species was abundant close to the shore at Black Beach, but was much less numerous in the upper parts of the island. Barrington is a low island, below 1,000 feet, and the species on it was just as abundant near the shore as farther inland. On Chatham S. literosa was common from the shore up to at least 1,500 feet. Hood Island has an elevation of only 650 feet, but the grasshoppers were just as abundant in the higher parts as near the shore. Tower Island is all low and flat.

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Hence the two species are separated from each other not by a difference in habitat, but by a difference of geographical location, i. e., one species is confined to one group of islands and the other species to another group.

If we had no specimens from Duncan Island the two first described forms of *Schistocerca* from the Galapagos could not be regarded otherwise than as two valid and well-separated species. A large number of specimens from Duncan, however, present such an amount of variation that they can be arranged in a closely graded series duplicating at one end the *melanocera* form and at the other the *literosa* form. At first sight this would appear to reduce these two supposed species to subspecies, but reasons will be given later for regarding the Duncan race as a hybrid.

RACES OF SCHISTOCERCA.

The specimens from the different islands show striking, though, in most cases, slight differences distinguishing the individuals of each island, as a race, from those inhabiting any other island. There are two exceptions. Abingdon and Bindloe have the same form, and Albemarle supports at least two races. Scudder was the first to point out the existence of races on the islands, but his material was alcoholic, and he could not, on that account, well describe such color differences between them as exist. Moreover, he had no specimens from Abingdon and Bindloe.

The following are the diagnostic characters of the various races. Detailed descriptions are given on pages 419-436.

S. melanocera melanocera (Pl. XXVII, fig. 1).—Of large size; yellow of metazona contrasts strongly with black of prozona, yellow spot on side of prozona distinct; abdomen uniform; terminal halves of tegmina immaculate.

From Charles Island.

This race may be regarded as typical of *S. melanocera*; and Charles Island is most probably the locality of Stål's *type* of thespecies.

S. melanocera minor.—Smaller than the Charles form; does not differ from it in color.

From Tagus Cove, Albemarle Island.

S. melanocera pallida.—Same size as the Tagus Cove form, but differs from this race in being of a generally paler color.

From Barrington Island.

S. melanocera lineata (Pl. XXVII, fig. 5).—Differs conspicuously from the Charles race in the presence of a distinct pale line along the side of the abdomen on the lower edges of the terga.

From Iguana Cove, Albermale Island.

S. melanocera immaculata (Pl. XXVII, fig. 6).—Resembles the Iguana Cove form in the possession of a light abdominal stripe, but differs from S. m. lineata and from all the other races in lacking the yellow spot on the side of the prozona. Since Scudder had two specimens which he says show a very faint trace of the prozonal spot, it is probable that some may be found having it well developed. Its absence, however, is so conspicuous that the race is a very strongly marked one.

From Indefatigable Island.

The species inhabits also Jervis, James and Narboro Islands, but the material at hand from these islands is insufficient to determine the status of the species on them. The few Narboro specimens show affinities to both the Tagus Cove and the Iguana Cove races on Albemarle.

S. literosa discoidalis (Pl. XXVII, fig. 4).—Smaller than any of the *melanocera* varieties, of a paler general coloration, lacking strongly contrasting black and yellow markings; terminal half of tegmina spotted with conspicuous large quadrate dusky blotches; prozona but slightly shorter than metazona.

From Chatham Island.

This race may be taken as typical of S. *literosa*, and it is probable that the *type* of this species came from Chatham Island.

S. literosa hyalina.—Conspicuously paler than the Chatham form, reticulations of tegmina lighter; tegminal spots smaller; prozonal stripes less strongly marked; prozona shorter than metazona. Eyes slightly farther apart than in S. l. discoidalis.

From Tower Island.

The Chatham and Tower forms are of about the same size, each being smaller than the Hood variety.

S. literosa punctata.—Distinctly larger than either of the other two literosa forms; the prozona relatively shorter, less than four fifths as long as the metazona; tegminal reticulation as in the Chatham form, tegminal maculations very distinct.

S. intermedia intermedia (Pl. XXVII, fig. 3).—Characters vary in all degrees from those of typical S. melanocera melanocera specimens, to those of typical S. literosa punctata specimens.

From Duncan Island.

S. intermedia borealis (Pl. XXVII, fig. 2).—Resembles in coloration intermediate Duncan individuals; color relatively uniform; maculation of tegmina well marked.

From Abingdon and Bindloe Islands.

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RELATIONSHIPS AND EVOLUTION OF THE RACES.

The characters of the species and their various races show little with regard to their interrelationships. If we leave out of consideration the Duncan specimens, there is no difficulty in referring the numerous other varieties to two well-separated species as has been done. Since, however, the Duncan specimens completely bridge over the wide gap between these two otherwise apparent species, we have a less simple problem to deal with.

Concerning the Duncan form we may make three suppositions as follows: (1) It may be an ancestral form, from one of whose extremes has been developed *S. melanocera* and from the other *S. literosa*; (2) it may be a variable race that on the one hand has varied toward *S. melanocera* and on the other toward *S. literosa*; (3) it may be a hybrid race formed by the intermingling of representatives of the other two species from the other islands.

There are several objections to (1). In the first place Duncan appears least likely of all the islands to have received the original Schistocerca population. It is situated near the center of the archipelago and is not more than three miles in its longest diameter. Structurally it consists of a circular extinct volcano, having an excentric crater with a floor about a third of a mile in diameter and 475 feet above sea level. The rim of the crater is still perfect, rising in most places to a height of about 350 feet above the floor. At one point it is produced into a sharp peak having a height of about 1,000 feet. The island is dry and barren. The whole outer slope is covered by a thick growth of low bushes, but soil is present only on the floor of the crater. Animal life is almost entirely confined to the interior of the crater. It is on this small area, affording absolutely uniform environmental conditions, that the most variable form of Schistocerca in the whole archipelago is found. It is highly improbable that an island of this sort could have been fit for habitation earlier than such fertile and much disintegrated islands as Chatham and Charles. Moreover, the winds and currents are invariably from the southeast. Hence, Duncan is in a poor location to send migrants to the islands south and east of it. Furthermore, it is impossible to imagine any reason why variations representing the literosa form should have gone to Tower, Chatham and Hood and not to any of the neighboring islands. On the other hand, Duncan gets but little rain, and the appearance of an island cannot be taken as a definite indication of its age. The presence of a very strongly marked race of land tortoise on Duncan might be taken as evidence of a considerable age for the island.

On the whole, however, the evidence is against the supposition that the ancestral race of *Schistocerca* lived on Duncan Island.

Under (2) we may assume that the Duncan race is simply a variety of either *S. melanocera* or *S. literosa* that has varied in the direction of the other species. The great improbability of such an occurrence is sufficient to exclude this hypothesis. We may also assume that the individuals on all the islands once varied as do now those on Duncan, and that on Chatham, Hood and Tower the *melanocera* characters were suppressed while on Albemarle, Indefatigable, James, Charles and Barrington the *literosa* characters were suppressed. However, it appears highly improbable that islands so dissimilar as Tower and Chatham should have produced the same form, and that islands so much more nearly alike as Charles and Chatham should have produced the same form, and that islands so much more nearly alike as Charles and Chatham should have produced the same form, should have produced forms so different.

Case (3), assuming the Duncan form to be a hybrid race, has no direct evidence in its favor. There is, however, nothing that can be urged against it. The central position of the island would permit stray individuals to be carried there by both wind and currents from Charles, Hood, Chatham, Barrington and Indefatigable. If the race is a hybrid then the incongruity of such a variable form inhabiting an island of so limited extent and of such lack in diversity of conditions is avoided. The assumption produces no discord with prevailing ideas concerning the relationship of environment and variation. However, as already stated, no direct evidence can be adduced in favor of the hypothesis. It is simply the only one that explains the facts and that cannot be disproved.

If, then, we regard the Duncan race as a hybrid, the relationships of the other races offers less difficulty. From a geological point of view Chatham and Charles are certainly the oldest islands of the archipelago. This is evident from (1) the disintegration of the surface lava, and (2) the destruction, by erosion, of the central craters. In the upper parts of the southwestern half of Chatham are large open fields of rich soil, strikingly contrasting with the condition of all the other islands except Charles and probably the upper part of Indefatigable. On Chatham are numerous rounded hills, giving evidence of long continued erosion, and there is no recognizable remnant of a central crater.

Charles Island appears newer than Chatham. The soil is thinner and less fertile. The surface rises gradually toward the center of the island where a number of high steep cone-like hills surround a central valley. These hills strongly suggest that they once formed the wall of a crater. Nearly all the other islands have well preserved craters, and

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almost no soil covering the surface lava. Hood, James, Barrington and Tower probably never had a single central crater, but all of them, except James, show little evidence of age.

The winds of the archipelago are almost invariably from the southeast. The humidity of the region is so small that islands less than 1,000 feet in height have but little precipitation. Consequently high islands lying to the south and southeast are the most favorably situated for receiving rain. Chatham and Charles possess both of these qualities. Hence, on them the condition of the surface cannot be relied on as a definite index of their age. They may appear older than another island of the same age that is lower and less favorably situated. Hood is just as well located as either Chatham or Charles, but it is too low to condense much moisture.

The contrast is so great, however, between Chatham and Charles and the other islands, that we cannot but suppose, even after making allowance for all other influences, that they were at least the first inhabitable islands of the archipelago. Albemarle rises far above all the islands east of it. To be sure, air currents must reach it somewhat impoverished in humidity by Chatham, Indefatigable, Charles and James, but its perfect craters and great fields of barren lava attest its newness. James and Indefatigable appear to be older than Albemarle but younger than Chatham and Charles. What the relative ages of such low islands as Hood, Barrington and Tower may be, however, it is difficult to judge. The rainfall on them is so slight that they may have remained unchanged for a long time.

A more serious difficulty in judging the age of an island arises from the consideration that only its present surface may be recent. A much older and fertile surface may be buried beneath it. This is true of Narboro. Most of the surface of this island consists of unweathered and utterly barren lava. There occur, however, scattered over its sides numerous isolated patches of vegetation growing on a rather rich soil. These areas vary from a few rods to half a mile in diameter, and are walled in on all sides by the recent flows of lava that have covered all the remaining surface of the island. These flows have occurred at different times and each has been of small extent. On such an island a fauna might easily migrate from one place to another as successively occupied areas became covered up.

In conclusion, then, with regard to the relative ages of the islands, all we can affirm is that Chatham and Charles have the appearance of being the oldest and first habitable islands of the archipelago. As we have seen, *Schistocerca literosa* is represented on Chatham and *S*.

melanocera on Charles. The characters of the races of each species as given above do not throw any light on the question as to which is ancestral in each case. Since the Iguana Cove and Indefatigable races of *S. melanocera* differ from the others in having a pale abdominal band, it is probable that they are secondary; and since the Indefatigable race has the unique character of an entirely black prozona, it has probably been derived from the Iguana Cove race. Otherwise we receive no help on this point from a study of the specimens themselves. Any form, as far as we can see, could be the direct descendants of the ancestors of the others in the case of either species.

If Charles and Chatham Islands are, as they appear to be, the oldest habitable areas of the archipelago, then it is most probable that they were the first islands inhabited by representatives of Schistocerca. Adopting this view, it is very easy to explain the status of the genus at present on the archipelago. We can suppose that the original form became modified on Chatham to S. literosa and on Charles to S. melanocera. From Chatham, we can suppose, individuals migrated to Tower and to Hood-each island being more accessible from Chatham than from Charles-and on these islands became the races peculiar to them. In the same way representatives from Charles could have gone to Barrington, Tagus Cove and Iguana Cove, and from the latter place to Indefatigable. To explain the Duncan race we have only to imagine that individuals from both Chatham and Charles were landed upon Duncan, there producing its hybrid literosa-melanocera race. Finally, individuals from Duncan could have gone to Abingdon and Bindloe Islands and there produced the Abingdon-Bindloe race. This relationship is diagrammatically shown on Plate xxvi.

It is evident that we might retain the same lines of relationship, but turn the direction of migration the other way. That is, we might suppose that the Abingdon-Bindloe race is the ancestral one, that from it was produced the variable race on Duncan, and that individuals representing one extreme of this race went to Chatham or Hood and individuals of the other extreme to Charles. From these islands the other varieties could radiate as before. The chief objections to this view are first that Abingdon and Bindloe are not very old islands, and second that migrants would have both the prevailing winds and currents against them. If the archipelago were inverted in position so that the northernmost islands were farthest south and *vice versa*, and if the then southern islands appeared to be the oldest, we could easily regard the Abingdon-Bindloe race as the unmodified original species, the Duncan race as a variable form produced from the first, and the others as being

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derived from the Duncan race. But, the facts being as they are, the seemingly less reasonable scheme outlined in the preceding paragraph appears to be the more probable course of the formation of the varieties as they at present exist on the different islands.

DETAILED DESCRIPTIONS.

SCHISTOCERCA MELANOCERA (Stål).

(Pl. xxvII, fig. I.)

Acridium melanocerum STÅL, Eug. Resa. Ins. Orth., p. 326, 1861.

Schistocerca melanocera SCUDDER, Bull. Mus. Comp. Zoöl., XXV, p. 11,

1893.

From Charles Island.

Description of a Typical Specimen. Female.-Ground color of head black, markings yellow. Pattern of the latter is as follows : a median stripe on the vertex, dilating slightly on the frontal lunule, and then going downward as a narrow line on the frontal costa to between the antennæ; below each antenna, on the floor of the subantennal groove, a wide stripe extending to, and less distinctly for a short distance upon the clypeus, the two being connected by a fine line along the lower border of the front; a third stripe reaching from lower part of anterior margin of eye downward along anterior border of gena a little more than half way from eye to base of mandible; a fourth stripe arising from the lower part of posterior margin of eye and running downward along posterior border of gena to the inferior margin of Antennæ uniform dusky; labrum with a bluish tinge; this sclerite. palpi yellowish, spotted with black; compound eyes dark brown; ocelli vellow. Prothorax has prozona black with an irregular quadratevellow spot on lateral angle of scutum. Metazona orange yellow with an encroachment of black from prozona along anterior border; posterior marginal thickening black, with a narrow line of black mottling just in front of it; otherwise punctate with black especially on dorsal aspect, yet the general orange yellow color contrasts strongly with the black color of the prozona. Whole prothorax with a median dorsal yellow carinal stripe continuous anteriorly with the median stripe of vertex and extending posteriorly to caudal border of metazona. Prosternum pale brownish, spine uniform with rest. Exposed lateral parts of meso- and metathorax black, on each an elongate yellow area along posterior border of the episternum ending below on a level with the mesothoracic spiracle. Sterna of same segments dark brown. Color in dry specimens a pale clay-color. Abdomen dusky, sides of terga dark brown on the posterior part, forming a wide transverse band on the anterior segments, a narrow band on the posterior segments.

Prothoracic coxa, trochanter and femur black, with a yellow stripe along the anterior outer border extending two thirds of distance to distal end of femur. Tibia and tarsus mottled with yellow and black. Mesothoracic legs same as prothoracic except that the lighter color is orange rather than yellow. The pattern of the coloration of the metathoracic femur is of special importance because the modifications it undergoes amongst the different varieties are of a definite and graded sort. Its ground color is black and the markings are as follows: along the median dorsal and the lateral outer and inner lower carinæ a very fine line of bright lake red; just above the outer lower carina a wide yellow stripe reaching a short distance back of the middle of the femur; a corresponding red line along the inner lower carina; saddled across dorsal surface from one upper carina to the other two large pale-red quadrate areas, the anterior the larger and separated from the posterior by a space equal to length of the latter, posterior border of second area lies just above caudal end of lower outer yellow stripe; continuous with the outer anterior angle of the anterior red area a yellow stripe running forward just above the outer upper carina to the cephalic end of femur where it curves downward so as almost to meet the lower yellow stripe; the lower outer and inner lobes of the posterior end of the femur with a yellow spot, and the upper lobes tipped with the same color. Metathoracic tibia and tarsus bright yellow; the upper end of the tibia, a row of small spots on the upper half of the outer surface, tips of the spines and tarsal claws, black.

Proximal halves of all longitudinal veins of tegmina bright lake red, otherwise premedian and postmedian areas of the forewings are distinctly differentiated. Membrane of premedian area pale lemon-yellow distally where most of the reticulations are of same color, but toward basal part of wing they are more yellowish and reddish. Reticulation and membrane of the distal two thirds of the postmedian area dark smoky-brown, while anteriorly the reticulations are yellowish, giving, especially on the side, just above the median vein, a lighter and more differentiated appearance to basal part of wing. Posterior wings pale lemon-yellow with strong infuscation apically.

Variations (11 specimens).—The majority of the specimens agree very closely with the *type*. The most frequent divergence is a tendency of the second red area of the hind femur to fuse across the lateral black space with the lower yellow stripe. Back of this second red area, there is, in many specimens, a more or less distinctly developed third spot between the second and the tip of the femur. In some the yellow and red colors are paler and the black less intense,

and there is often less black on the metazona than in the first specimen described. The abdomen is sometimes paler, due to a spreading of the brown over all the parts. There is only a slight variation in the intensity of the color of the tegmina.

The males and females differ from each other in no way except in size. Length of tegmina of *male*, 44, 41, 41, 48, 45 = 44 mm.; of *female*, 55, 56, 58, 55, 53, 49 = 54 mm.

SCHISTOCERCA MELANOCERA MINOR var. nov.

From Tagus Cove, Albemarle Island.

Description of the Type. Female.—The type of the Tagus Cove race on Albemarle is almost identical in color with the Charles Island example, differing from it only in the following points : metazona less distinctly contrasted with prozona, being of a dusky orange color rather than yellow as with the Charles Island specimen, so that the irregular black markings, although present, are less conspicuous; there is scarcely any black on the prothoracic femur; yellow areas of the episterna small and less conspicuous; red of the metathoracic femur paler, and second red area fused below, on left side, and almost so on right, with lower yellow stripe; third or posterior spot on the dorsal surface of femur well developed; color of abdomen uniform, being dark brown obscurely mottled with dusky; distal half of the postmedian part of the tegmina paler. Length of tegmina, 47 mm.

Variations (16 specimens) .- The other specimens from Tagus Cove show but little difference in color from the Charles Island specimens; specimens can be selected that duplicate the type from Charles Island, while as a whole the specimens from the two islands present exactly the same variations. One difference, however, is noticeable in most of the Albemarle specimens and that is that the infuscation of the distal half of the postmedian part of the tegmina averages slightly less than in the specimens from Charles. In the specimens from both the islands the yellow of the basal part of the wing just above the median vein has a tendency to be so arranged as to show the dark color as a longitudinal series of blotches. In most of the Tagus Cove specimens the second red area of the hind femur is fused across the intervening black space with the yellow line, and at least an indication of the third dorsal spot is present in almost all. Length of tegmina of male, 39, 39, 36, 40, 38, 38, 4I = 39 mm.; of female, 50, 49, 44, 49, 43, 47, 48, 42 = 47 mm.

These figures show that there is a very considerable difference in size between the grasshoppers at Tagus Cove, Albemarle and the

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grasshoppers of Charles Island. In fact the females of the former are but slightly larger than the males of the latter. This difference is especially noticeable to one collecting at the two places, and there can be no doubt that the smaller size of the Tagus Cove specimens is a character distinguishing them as a race from those inhabiting Charles Island. Scudder's sixteen males and seven females from Albemarle average considerably larger than those of the Stanford collection, but he does not state on what part of Albemarle they were collected, and, as will be shown, there is a different race at the south end of Albemarle, and there might be another on the east side.

SCHISTOCERCA MELANOCERA PALLIDA var. nov.

From Barrington Island.

Description of the Type. Female.—Similar to S. m. minor of Tagus Cove, but differing from the type of that variety in having the metazona of a pale yellow color with but little black, in having a pale yellow area on the side of the scutum near its lower margin, and in the larger size of the episternal yellow areas. Length of the tegmina, 51 mm.

Variations (11 specimens).—The Barrington specimens average distinctly paler than the Tagus Cove specimens. The infuscation of the apical half of the postmedian area of the tegmina is much less in the males than in the Tagus Cove males, the same area being marked with indistinct dark spots. The three females, however, have the tegmina about the same color as those of *S. m. minor*. They all possess the yellow spot on the angle of the scutum, and all the males and two of the females have a second less distinct and less well-defined blotch of the same color near the lower margin of the scutum and præscutum. Scudder's figure, drawn from a Barrington Island specimen, shows this lower yellow area. One Tagus Cove specimen also possesses this spot pretty well marked on each side.

Length of tegmina of *male*, 39, 40, 37, 38, 37, 42, 39, 39 = 39 mm.; of *female*, 49, 50, 51 = 50 mm.

The Barrington form is then closely related to the Tagus Cove form and is related to it more closely than to any of the other races. It differs from S. m. minor chiefly in the lighter colored tegmina of the males, and in the greater frequency of the lower yellow spot on the side of the scutum, the absence of this mark being exceptional while with the Tagus Cove form its absence is characteristic. Their affinities, hence, are not with the Duncan race as Scudder judged from his specimens.

SCHISTOCERCA MELANOCERA var.?

From Jervis Island.

Scudder had one male specimen from this island, which he says "is almost an exact duplicate of some of the similarly sized males from Albemarle Island, with faintly infumated wings." There are, however, at least two distinct races on Albemarle, so that the relationship of the Jervis form must be left doubtful since we did not visit this island.

SCHISTOCERCA MELANOCERA LINEATA var. nov. (Pl. xxvii, fig. 5.)

From Iguana Cove, Albemarle Island.

Description of the Type. Female.— Differs in the following characters from S. melanocera melanocera: abdomen very dark brown, lower edges of the terga yellow, forming a conspicuous stripe along the side of the abdomen; meso- and metasterna dark olivaceous-slaty, with a pale stripe on each side reaching from the mesocoxa to the anterior border of the mesosternum just back of the anterior coxa. Length of the tegmina, 53.5 mm.

Variations (18 specimens).—This variety is very distinct from the race at Tagus Cove on Albemarle, and, as will be shown, possesses the lateral abdominal stripe in common only with the Indefatigable and Seymour variety. Hence it appears to be related on one hand to the form inhabiting these islands and on the other to the Tagus Cove and the Charles races. All of the specimens have the lateral stripe on the abdomen, although its intensity varies. This mark is present on two of the Tagus Cove specimens but is much less distinct than in the majority of the Iguana Cove specimens. The lateral pale lines on the mesosternum are present on some of the Tagus Cove specimens as a mere suspicion of their existence.

Length of tegmina of *male*, 39, 40, 39, 38, 38, 39, 40, 40 = 39.1 mm.; of *female*, 55, 53, 48, 54, 45, 54, 52, 50, 50, 48 = 50.9 mm.

SCHISTOCERCA MELANOCERA IMMACULATA var. nov.

(Pl. xxvII, fig. 6.)

From Indefatigable Island and South Seymour Island.

Description of the Type. Male.—Agrees most closely with S.m. lineata of Iguana Cove, but differs conspicously from the type of that race as follows: frontal costa and entire lower part of face including the clypeus and labrum yellow, except for a slight brownish area just below frontal ocellus; metazona bright pale yellow; no yellow spot on

the angle of the scutum; yellow spots on episterna entirely absent on left side, minute on right side; abdomen more blackish, with yellow borders to lower ends of terga but also with the posterior margin of both terga and sterna yellow. Length of tegmina, 42 mm.

Variations (6 specimens).—In coloration the specimens agree with the type in lacking the yellow spot on the angle of the scutum, none of them showing the least trace of it. This character separates this race very distinctly from all the other forms so that it, more than any of the others, deserves the rank of species. Scudder had six males and seven females from Indefatigable Island, and he states that all except two lack this spot, these two, however, showing but "a faint trace of it." One female has the entire face yellow as in the type but the others resemble the forms already described in the coloration of the head. The inferior surface of the meso- and metathorax is, in most of the specimens, slaty-olivaceous, but the lateral stripes on the mesosternum from the pro- to the mesothoracic coxal cavities are generally not very distinct although faintly present. All have the abdominal terga bordered inferiorly with pale yellowish, strongly resembling in this respect the Iguana Cove form, but differing from them in that the color is present also on the entire posterior margins of the segments, extending more or less distinctly entirely across the dorsal aspect of the abdomen and conspicuously bordering all the sterna. The color of the tegmina exactly duplicates that of the Iguana Cove specimens.

Length of tegmina of *male*, 42, 42, 45 = 43 mm.; of *female*, 61, 59, 45 = 55 mm.

These figures are slightly greater than those given by the measurements of the Charles Island specimens. Scudder's measurements also show that the Indefatigable form is the largest. In collecting on Seymour Island after being on Albemarle the greater size of *S. m. immaculata* was strikingly conspicuous. This race is, therefore, although very distinct, more closely related to that at Iguana Cove than to any other, differing from *S. m. lineata* in the larger size and in lacking the lateral spot of the scutum.

SCHISTOCERCA MELANOCERA var.?

From James Island.

When we visited James Island in April, specimens of adult *Schisto-cerca* were extremely scarce and no specimens were secured. Immature specimens were everywhere abundant. About the time the young are born the old ones die. Scudder had one male and two females from this island, and, according to him, they most closely resemble the

Indefatigable specimens, differing from them in having the lateral spot on the scutum "tolerably distinct in all, and in one very fairly marked."

SCHISTOCERCA MELANOCERA var.?

From Narboro Island.

There are only three specimens in the collection from Narboro Island, and they do not agree with one another nor with any other one form. One specimen resembles the Iguana Cove specimens of Albemarle; it has the lateral stripe on the abdomen well marked, contrasting strongly with the very black color of the rest of the abdomen, although the stripe itself is reddish-brown. One of the other two specimens differs from the first in having the lateral abdominal stripe not so distinct. The third specimen, a male, differs from the first and second in lacking the abdominal stripe and in having the abdomen and the ventral surface of the thorax pale. This one resembles the specimens from Tagus Cove. The distance between Narboro and Tagus Cove is only about three miles and it is scarcely to be supposed that the grashoppers do not sometimes cross from one island to the other.

Length of tegmina of male, 40 mm.; of female, 50, 47 = 48.5 mm.

SCHISTOCERCA LITEROSA (Walker).

(Pl. xxvII, fig. 4.)

Acridium literosum WALKER, Cat. Derm. Salt. Brit. Mus., IV, p. 620; V, Suppl., p. 63.—BUTLER, Proc. Zoöl. Soc. Lond., 1877, p. 88. Schistocerca sp. BRUNNER, Proc. U. S. Nat. Mus., XII, p. 193.

Schistocerca literosa discoidalis SCUDDER, Bull. Mus. Comp. Zoöl., XXV, p. 16, 1893. (Chatham Island.)

From Chatham Island.

Scudder has tabulated characters on which he separates the Schistocerca of Chatham, Hood and Tower Islands into three distinct races, and these races he designates by variety names. The collection here reported on is much more extensive than that of Scudder, being represented by sixty-four specimens from the three islands, and, while some of Scudder's characters do not hold, the most important ones do.

Description of a Typical Chatham Specimen, Female.-Head dull reddish-brown with black and obscure yellowish markings; a black stripe extending from middle of posterior border of eye backward and downward to pronotum, split by a narrow line of the general color of head; just below eye a small black spot; space back of this and below post-ocular stripe and extending to lower border of gena slightly paler and more yellowish than rest of head; two rows of irregular black punctations on vertex on each side of median line.

Antennæ pale at base, beyond this dusky, the segments ringed distally with narrow marginal band of yellowish. Pronotum yellowish-brown, irregularly punctate with black, metazona with a reddish-brown diffusion, especially posteriorly; upper part of side of prozona with two poorly defined black stripes, one continuous with upper half of postocular stripe and the other with the lower. Meso- and metathorax same color as pronotum, punctate with black on sides, paler and without black spots below. Prothoracic and mesothoracic legs same color as thorax, marked with small black spots; metathoracic femur paler than rest of body, with a row of distinct black spots along upper and lower outer carinæ, lower ones being the larger, two very indistinctly outlined black saddle spots across the dorsal half, one just in front of, the other just behind, the middle, femur terminally dusky; tibia color of rest of the body with spines yellowish, tipped with black, a row of small black spots along inner side of tibia. Tegmina with no differentiation of membrane of the pre- and post-median areas, veins of the latter, however, all dusky, those of former paler brownish; dorsal surface of closed tegmina with distinct rusty tinge; on sides numerous black maculations, basally these are especially black and are elongated, distally they are paler, smaller and more equal-sided. Abdomen light brown with terga mottled with irregular longitudinal black streaks.

Length of tegmina, 34 mm.

Variations (16 specimens).—The head is generally almost uniform dull yellowish, yellowish-brown, or reddish-brown, with the posterior part of the genæ yellowish in all cases. The post-ocular stripe is always present. The prozona has generally a broad, pretty distinct black band along the upper part of the lateral lobes, continuous in front with the black post-ocular stripe. Sometimes this band is solid black, sometimes it is entirely split lengthwise by a yellowish band, and sometimes the yellow forms merely a small spot in the black, in which case the spot is on the scutum. Below this the prozona is dull yellowish-brown, dorsally it is darker. The metazona is in nearly all cases uniform brown. The black blotches on the hind femora are generally not so well formed as on the Hood Island specimens, and the black longitudinal connecting band is seldom present. There is a distinct tendency toward a yellow coloration of the median dorsal part of the pronotum and of the inner margins of the tegmina, making a median dorsal yellowish band. This is well marked in some and in others entirely absent.

Length of tegmina of *male*, 26, 28, 29, 27, 24, 27, 28, 30, 28, 27 = 27.4 mm.; of *female*, 33, 32, 34, 32, 34, 36 = 33.5 mm.

Length of prozona: 7, 6.5, 6, 7.5, 6.5, 6.5, 6.5, 6.5, 6, 6, 6 = 6.4 half mm.

Length of metazona: 8, 7.5, 7, 7.5, 7, 6.5, 6.5, 7, 6, 5.5, 7 = 6.8 half mm.

Prozona : metazona = .94.

SCHISTOCERCA LITEROSA HYALINA Scudder.

Schistocerca literosa hyalina SCUDDER, Bull. Mus. Comp. Zool., Vol. XXV, p. 16, 1893. (Tower Island.)

From Tower Island.

Description of a Typical Specimen. Female.-Differs from the specimen described from Chatham as follows : black below eye extending farther ventrad, defining more distinctly the yellowish color of posterior part of genæ; a small black area just above base of mandible; punctations along each side of median line of head fused into two bands leaving a longitudinal median yellow stripe well defined between them; post-ocular stripe present, less conspicuous and very indistinctly divided by lighter color. Lateral stripes on prozona exactly as on the Chatham specimen; a faint indication of a median dorsal stripe on prozona; punctations of meso- and metathorax and of first and second pairs of legs fewer; small spots along upper outer carina of hind femur absent, those of lower carina present but much smaller; large black dorsal areas of posterior femur much more distinct and better defined, a third one indistinctly present in front of the first one of the Chatham specimens; maculations of tegmina fewer and fainter especially distally, only one spot on each side on the premedian area; reticulations of tegmina all pale gray, except on dorsal surface of closed tegmina where they are brown; veins reddish basally, brown mesially, gray terminally.

Variations (14 specimens).—The Tower Island specimens differ from those of Hood and Chatham in being of a conspicuously paler coloration, due mostly to the paler reticulations of the tegmina. The pattern of the coloration agrees more closely with that of the Hood specimens than with that of the Chatham specimens. The black bands inclosing a yellow one along the upper parts of the lateral prozonal lobes are well marked but average a little paler than on the Chatham Island specimens. The post-ocular stripe is present on the head in all. In respect to the intensity of the lateral prozonal stripe the Tower specimens are intermediate between those of Chatham and those of Hood. Below the lower black stripe the color is uniform dull yellowish-brown. The median dorsal prothoracic stripe is obso-

lete on most of the specimens, but the median stripe of the vertex is somewhat more distinct. The black dorsal spots of the posterior femora are not united in any of the specimens by a lateral black band. The maculation of the tegmina is very distinct but the spots are not so large as on the Chatham Island specimens, resembling more the Hood Island form in this respect. The antennæ are either uniform dusky throughout or have the basal segments pale yellowish and those beyond bordered distally with the same color.

Length of tegmina of *male*, 27, 29, 28, 27, 29, 27, 27, 27 = 27.5 mm.; of *female*, 35, 34, 32, 34, 35, 33 = 34 mm.

Length of prozona: 6, 6, 5.5, 7, 6, 7, 7, 6.5, 6, 6 = 6.3 half mm. Length of metazona: 7, 7, 6.5, 8, 6.5, 7.5, 7.5, 8, 6, 6.5 = 7.1 half mm.

Prozona: metazona = .88.

The above figures show that there is little difference in size between the Chatham and Tower specimens. The relative length of the metazona, however, is considerably greater than in the Chatham specimens, where the metazona is but slightly longer than the prozona. In this respect also the Tower form is midway between those from Chatham and those from Hood. Scudder showed that this is true of the specimens he had. As also stated by Scudder, the space between the eyes of the Tower specimens is relatively greater than that between the eyes of the Chatham specimens. All of the latter have the space between the eyes on the vertex much narrower than the narrowest part of the frontal costa, while, in the Tower specimens, this space varies from the width of the frontal costa to slightly narrower.

SCHISTOCERCA LITEROSA PUNCTATA Scudder.

Schistocerca literosa punctata SCUDDER, Bull. Mus. Comp. Zoöl., Vol. xxv, p. 16, 1893. (Hood Island.)

From Hood Island.

Description of a Typical Specimen. Male.—The coloration is very similar to that of the Chatham and Tower specimens. The Hood specimen presents the following characters: on the head, in addition to the pale yellowish area of the posterior part of the gena, there is a similarly colored but poorly defined area beneath the eye; a median stripe on vertex extending on front to between antennæ of same color, on vertex this stripe bordered on each side by a band of dusky, between which and the post-ocular stripe is a broad yellow area; lower part of front dusky; clypeus and labrum dull brownish-yellow, mottled with black; metazona uniform brown; prozona same color on

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dorsal surface, somewhat invaded by yellowish, at the lateral angle a faint narrow longitudinal band of yellow, below this a similar band of black, and below this again a second yellow band slightly wider than the upper, below which and reaching the lower margin of the prozona punctate black; thoracic sterna alike in color, pale leathery brownish-yellow; sides of meso- and metathorax dull yellowish-brown, somewhat browner than the sterna, with small amount of dusky infusion; a pale yellowish median carinal stripe on pronotum; fore and middle legs of same color as sides of mesothorax, both femora and tibiæ marked with small black spots; ground color of hind femur about same as color of metasternum; on dorsal aspect of femur, reaching across from middle of one side to middle of other, three large rectangular black areas, between which are yellowish areas of same size, the first is a little in front of middle of the femur, the most posterior terminal and the median half way between the other two, lower margin of the first and the second indistinctly united by a faint longitudinal black band; rest of the femur shaded with brown, and along the outer lower carina punctate with black; abdomen plain brown; tegmina pale brownish, paler and somewhat yellowish, on premedian part, postmedian area maculate with quadrate dusky spots, largest and blackest anteriorly.

Variations (34 specimens).-In some specimens the color of the body is almost uniform dull reddish-brown, paler and more yellowish beneath with most of the markings on the head obsolete and those on the prozona very faint. The lower black stripe and upper yellow one of the prozona are the most persistent markings. In most of the specimens there is present with varying distinctness a black stripe just above the upper yellow stripe, so that the markings of the prozona are better described as a black longitudinal band on the upper part of the sides, split with yellow, below which is a wide yellowish area and between it and the lower margin of the prozona the color is punctate black. In some cases the upper yellow band is almost obliterated by a fusion of the two bordering black stripes, or the yellow is left as a small spot in the middle of a wide black band. In other cases both the yellow and the black are obscure, or the yellow forms a small spot at the angle of the scutum with a slight amount of black below it. The postocular stripe of the head is in most cases split longitudinally with yellow and the two parts are continuous with the two black bands of the prozona. The head in most cases has a faint median stripe on the vertex continuous posteriorly with the equally faint median stripe on the pro- and metazona. The latter stripe is lacking in only a few

cases. The antennæ are generally pale basally but otherwise dusky. The black spots of the femora are in some cases indistinct and not connected by a lateral black band. The black punctations of the lower outer carina of the femur and of the side of the tibia are persistent. In most cases the large black spots of the femur are well marked and in some cases have their lower outer ends connected by a very wide, distinct lateral black band leaving only a narrow stripe of yellow below Also, the specimens show a tendency in the species, toward the it. formation of a fourth black spot just back of the trochanter of the hind leg. This spot is united with the lateral external black band of the femur, as are the other spots, when this band is well developed. The maculation of the tegmina varies considerably, the spots being in some cases indistinct and in others very black, especially basally, where they are also sometimes considerably fused; but in general the markings are very prominent. The posterior wings are uniformly pale.

Length of tegmina of *male*, 32, 30, 31, 37, 33, 33, 31, 33, 32, 30, 31, 31, 33, 31, 32, 31, 30 = 31.8 mm.; of *female*, 40, 40, 41, 39, 39, 38, 38, 36, 35, 39, 35, 38, 35, 35, 37, 38, 36 = 37.6 mm.

Length of prozona : 7, 6.5, 7, 6.5, 7.5, 7, 7, 7, 7, 7, 6.5 = 6.9 half mm. Length of metazona : 8, 8, 9, 9, 10, 9.5, 9, 9, 8, 8 = 8.75 half mm. Prozona : metazona = .79.

Though the literosa forms closely resemble one another as the preceding descriptions show, yet each possesses several distinguishing characters. S. l. punctata of Hood is distinctly larger than the varieties on Chatham and Tower Islands which are of about the same size. The length of the metazona, measured along the mid-dorsal line, compared with the length of the prozona, is much greater in the Hood Island race than in the Chatham Island race, while those on Tower are intermediate between the others in this respect. The space between the eyes as compared with the least width of the frontal costa, is certainly, as pointed out by Scudder, narrowest in the Chatham Island specimens and widest in the Tower Island specimens, being in the former much narrower than the narrowest part of the frontal costa, and in the latter varying from the width of the frontal costa to very slightly narrower. The Hood specimens all have the space between the eyes on the vertex narrower than the least width of the frontal costa, but the difference in this respect between them and the Tower specimens is scarcely perceptible. The specimens do not show the differences in the punctation of the frontal costa above the ocellus, nor of the metazona, mentioned by Scudder. The lateral black stripes on the lateral lobes of the prozona average a little darker on the Chatham specimens

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than on those of Tower; and, in all, the post-ocular stripe is present on the head, being not absent on the head in the Tower specimens as tabulated by Scudder for his specimens. On the Hood Island specimens the lateral prozonal markings average much less distinct than on those from Tower or Chatham. With regard to this character, then, the Tower specimens are intermediate between the other two but closer to the Chatham form. The maculation of the tegmina is certainly darkest and the spots are largest, especially basally, on the Chatham specimens, while in this respect the Hood and the Tower specimens are almost identical and do not show the differences described by Scudder from his specimens. The differences in the color of the veins and reticulation of the post-median area of the fore-wings, pointed out by Scudder, namely that the Tower form has these parts pale gray and the others brown, is true of all the specimens, and gives the Tower race a paler appearance.

These comparisons show that no one of the three varieties is more closely related to one than to the other of the other two. *S. l. hyalina* of Tower is the only one that possesses a character not shared in some degree by the other two—the pallid color of the veins and reticulations of the fore-wings distinguishes it from the others—and hence it is probable that the Tower race has been derived from the inhabitants of one of the other islands, rather than that the others were produced separately from a form with pale wing veins. However, since either of the brown-veined forms may have been derived from the other after it had come from a pale-veined form, there is no certain evidence at all that any one rather than either of the others might be the ancestral race.

SCHISTOCERCA INTERMEDIA sp. nov.

(Pl. xxv11, fig. 3.)

From Duncan Island.

Description of the Type. Female.—General color of the head yellow, a brownish area at lower end of frontal costa, clypeus and labrum with dusky markings, frontal lunule dark on sides, a postocular stripe present narrowly split with yellow, a short black stripe extending from lower border of eye half way down middle of gena, a distinct yellowish vertical stripe reaching to frontal costa, space between this vertical stripe and the eyes and post-ocular stripe punctate with black, a few black punctations on anterior edge of gena below front of eyes. The general color of the head is thus marked off by the black into several areas; one of these is along the posterior part of the gena from the post-ocular stripe and eye down to the lower border of the gena; another is below the anterior part of the eye in

front of the subocular stripe and back of the black punctations along the anterior edge of the gena; a third is in front of these spots and laterad of the frontal costa, occupying the subantennal groove. It will be seen from this description that these areas correspond exactly with the yellow markings of the sides and front of the head of all the S. melanocera forms. Prozona with a very distinct median yellow stripe continuous in front with the median yellow stripe of vertex and posteriorly extending rather reduced across metazona; dorsal parts of prozona to level of post-ocular stripe, dusky, very slightly darker along outer margin, on the angle of scutum and scutellum a wide yellow band, below this the sides of the prozona reddish-brown with an admixture of dusky showing a tendency to intensify along the lower margin of the yellow above. This character, therefore, recalls the yellow stripe along the angle of the prozona in the literosa forms, with a black stripe above and another below it. Metazona in general paler than prozona, uniform reddish-brown, contrasting conspicuously with the darker colored prozona; along the anterior border an infusion of dusky, especially above, from the prozona, and punctations of the same color along the posterior margin. Sides of meso- and metathorax plain reddish-brown, lower surfaces uniform, darker than the sides. Abdomen brown with black streaks.

Prothoracic and mesothoracic legs reddish-brown with black mottlings. Metathoracic femora with the general color yellowish; entire inner surface between the two inner carinæ, except a short space just in front of posterior swelling, black. Two large black spots on dorsal side reaching from inner black area to middle of outer side; from anterior one of these spots a line of black mottling runs forward along middle of femur to near anterior end; lower lateral lobes of posterior enlargement yellow, upper lobes black with yellow tips, space between on dorsal surface posteriorly yellowish with brown spots, anteriorly black; lower outer and lower median carinæ, with a row of small black spots. Tibiæ plain yellow, with obsolete dark spots along upper parts of sides, spines black-tipped. Tegmina with the veins pale reddish-brown, the reticulation of the post-median area gray or gravish-brown, those of the premedian area pale gray, postmedian area with distinct dark quadrate maculations, most distinct anteriorly where they are also elongate and crowded; posterior wings almost uniform pale with a very slight apical infuscation. Length of tegmina, 53 mm.

Variations (25 specimens).—The specimens from this island form as a whole a well-marked race, but present a great amount of variation

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amongst themselves. In general they are of a conspicuously graver coloration than any of the S. melanocera forms and this character is especially noticeable when they are observed flying in the field, being conspicuous mainly on account of the paler colored tegmina and the almost uncolored posterior wings. One specimen, the least typical of the lot, is almost an exact duplicate of any typical Charles Island specimen, differing from the Charles type figured merely in having the median red dorsal area of the hind femora almost fused with the lower yellow line, and in having the third dorsal spot present on the femur. Also there is a row of small spots along both sides of the upper end of the tibia. These characters, however, are possessed by many of the Charles specimens. On the head the yellow bands before and behind the eye are fused along the lower part of the gena, but one Charles specimen duplicates this character. The distal part of the tegmina in some of the Duncan specimens, has exactly the same shade as in the Charles specimens and entirely lacks maculations. The average size of all the specimens from Charles and of all from Duncan is practically the same. On the other hand, specimens at the opposite end of the series are indistinguishable in color from Hood Island specimens. One specimen, in fact, resembles the typical Hood Island specimens even more closely than the one just described resembles the Charles type. On the lateral angle of the prozona is a pale yellowish band extending the whole length of the prozona, above it is faintly and narrowly bordered with black (the median dorsal part of the prozona. being reddish-brown), below it is an indistinct band of equal width of punctate black, below this again is an indistinct band of yellow and from this to the lower border of the prozona the color is yellowish, finely spotted with black. This is exactly the same pattern as is present on the Hood Island specimens. Large and small black markings are present on the hind femora exactly the same as on Hood specimens, and the left tibia is spotted above on the outer side. The head is almost uniform yellowish-brown with faint black post-ocular bands. The antennæ are pale reddish-brown basally but dusky beyond. The abdomen is plain brown.

In general the specimens show a strong tendency toward a uniformity of coloration; the yellow markings of the head are in most cases fused across the separating black spaces so as to almost obliterate the latter. The metazona in most cases is not nearly so distinctly differentiated from the prozona in color as in the *melanocera* forms, the uniformity being due to a diffusion of the dark color of the prozona into the yellow of the metazona. As shown in the drawing of the type

from this island the yellow at the angle of the scutum extends to the posterior border of the scutellum. The yellow has spread over the top of the head so that the general black color is confined to a post-ocular stripe between the color of the vertex and the post-genal yellow stripe of the *melanocera* form. Furthermore, this black post-ocular stripe is split longitudinally with yellow. This replacement of the black by the yellow until the latter becomes the ground color and the black appears as markings is characteristic of the whole Duncan race, yet the specimens grade imperceptibly from the extreme representing the Hood type into that representing the Charles Island type.

The sides of the mesothorax and of the metathorax are in all nearly uniform brownish-yellow. The abdomen is brown with black mottlings and without pale borders to the segments. The hind femora are generally of a rather faded appearance but possess most of the black *melanocera* femoral markings undiminished in size. The tegmina of nearly all are grayish in color, being noticeably so when a specimen is seen alive flying, and the reticulation is almost everywhere pale. The maculations are as described in the *type*. The longitudinal veins vary from red to a reddish-brown—a vein-color not present in any of the *melanocera* forms, being more nearly the vein-color of the *literosa* varieties. The posterior wings are plain as in the *type*.

There can be no doubt that this race is intermediate between the forms from Charles and from Hood and it is evident that the change in color pattern from the Charles *type* to the Hood *type* consists of a spreading of the yellow markings of the former over the black ground color until the relationship of the two colors is reversed, and the black appears as markings on a yellowish ground. In addition to this difference of color pattern there is a difference of general tone of coloration, and of presence and absence of markings on the tegmina.

Length of tegmina of *male*, 42, 44, 44, 43, 44, 42, 42, 41, 43, 41, 41, 42 = 42.3 mm.; of *female*, 54, 50, 53, 54, 54, 53, 47, 52, 54, 54, 56, 55 = 53 mm.

In general the Chatham Island form presents fewer variations in the direction of the Duncan variety than does the Hood Island form, and such variations as are in that direction do not go nearly so far as do some of the variations found amongst the Hood specimens, but tend rather to connect the Chatham race with the typical specimens from the latter island. The Hood race, therefore, is intermediate between the Duncan race and the Chatham race. The relationship holds specially with regard to size, the Hood form being the largest of all the *literosa* varieties.

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SCHISTOCERCA INTERMEDIA BOREALIS var. nov.

(Pl. xxvII, fig. 2.)

From Abingdon and Bindloe Islands.

Description of the Type. Male .- From Abingdon Island. Head almost uniform pale yellowish-brown; on the vertex two brownish stripes arising between eves and diverging somewhat backward, inclosing between them a yellowish median stripe which is lost in front in the general pale color of the head; two excessively faint post-ocular stripes on each side running downward and backward; antennæ color of head basally, otherwise dusky; eyes uniform in color with head. Entire prothorax almost uniform yellowish-brown; a very faint median dorsal stripe of yellowish scarcely reaching posterior border of metazona; a well-marked but pale longitudinal yellowish area on angle of scutum and scutellum, very faintly bordered above and below by dusky; metazona bordered posteriorly by a row of very indistinct dark spots; most of pronotum minutely punctate with black. Sides of mesothorax and metathorax colored as pronotum, sterna of same segments paler and not punctate. General color of abdomen uniform with that of thorax, the sterna being paler than the terga, the latter streaked longitudinally with short indistinct curved black lines.

Fore and middle legs uniform yellowish-brown. Metathoracic femora slightly paler than body; two pale dusky quadrate blotches on the dorsal half, reaching from middle of outer to middle of inner side, the anterior on the inner surface of femur spreading out so as to form a large diffused black area anteriorly between the upper and lower carinæ; the lower outer ends of the dorsal blotches are connected by a longitudinal line of indistinct black punctations; a row of small black spots along lower outer and the ventral median carinæ; inner lower carina reddish; lower lobes of posterior femoral enlargement yellow, upper lobes black, tipped with yellow, dorsal surface between them pale, spotted with black; dorsal surface of femur tinged with reddish, upper median carina conspicuously red with small dusky-red spots along its entire length. Posterior tibia mostly plain yellow, upper end and tips of spines black, a few very indistinct dusky spots on outer side above.

Tegmina darker than body; reticulation of premedian area pale gray, membrane pale; reticulation of post-median part brown, membrane everywhere infuscated. The longitudinal veins bright red basally; large dark quadrate maculations distinct, crowded basally. Posterior wings strongly infumated apically. Length of tegmina, 38 mm.

Variations (18 specimens).—In color the Abingdon specimens differ decidedly from any others so far described in having the yellow color of the head and thorax predominant over the black, and the red of the posterior femora predominant over the black there. In many there are distinct indications of black markings as in the type, but in others the color is a uniform dark reddish- or yellowish-brown with scarcely any indication of yellow and black. There is no contrast at all between the prozona and the metazona. Those that have the prozona darkest have a well-developed yellow spot at the angle of the scutum on each side. The wings of the darkest specimens are darker than the wings of those with pale colored bodies, but in all the maculation of the fore wings is well marked and closely resembles the maculation of the tegmina of the Duncan Island specimens, being in most cases better marked than in the type figured.

Length of tegmina of the Abingdon specimens, *male*, 36, 36, 38, 37, 35 = 36.4 mm.; *female*, 47, 47, 47, 48 = 47.25 mm.

The Bindloe specimens differ in no way from those on Abingdon and it is apparent that those from the two islands represent but a single species. Although the specimens present numerous variations amongst themselves yet they are as a whole distinctly separated from any other race.

Length of tegmina of the Bindloe specimens, *male*, 37, 35, 43, 37 = 38 mm.; *female*, 47, 50, 49, 50, 49 = 45 mm.

From the above descriptions it is easily seen that the Abingdon-Bindloe race certainly resembles most the intermediately-colored individuals on Duncan Island.

Genus Sphingonotus.

GENERAL REMARKS.

This genus inhabits the central and southern islands of the archipelago, being known only from Albemarle, Indefatigable, Barrington, Chatham, Hood and Charles. Furthermore, it is for the most part, found only in the dryer parts of these islands. For example, on Albemarle it is present on the arid region about Tagus Cove, but is absent in the humid district about Iguana Cove.

The seven races, into which the Galapagos specimens may be separated, form two groups that appear to constitute two closely related species. One group inhabits Chatham, Albemarle and Indefatigable; the other inhabits Barrington, Hood, Charles and Indefatigable. The occurrence of two races on Indefatigable may be regarded as evidence of the presence of two species.

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Since Stål described S. fusco-irroratus from Puná Island and from the Galapagos without naming a type locality, I shall restrict the name fusco-irroratus to the Puán individuals, and call the two Galapagos species S. trinesiotis and S. tetranesiotis. This nomenclature would, of course, not hold in case the Puná specimens should turn out to be identical with any of the Galapagos races.

DIAGNOSIS OF Sphingonotus RACES.

The following are diagnostic descriptions of the races of *Sphingo*notus. Detailed descriptions follow on pages 439-447.

Sphingonotus trinesiotis chathamensis.—General color pale greenish clay-color. Genæ of same color as rest of head but paler; postocular and lateral prozonal stripes present; pale diverging stripes along angles of metazona, tegminal maculations confined to sloping surfaces of closed wings; no dark vertical stripe on hind femur; lower three fourths of hind tibia dusky.

From Chatham Island.

Sphingonotus trinesiotis indefatigabilensis.—A very distinct race. Genæ distinctly paler than rest of the head and of a slaty tone; post-ocular and lateral thoracic markings very distinct and strongly resembling those of *chathamensis*; pale diverging bands on angles of metanotum present as in the Chatham race but less distinct; a pale line along the angles of the closed tegmina; maculations of the tegmina confined to the sloping surfaces.

Resembles the Chatham race in the bands of the head and thorax, and the Albemarle race in the slaty coloration of the genæ.

From Indefatigable Island.

Sphingonotus trinesiotis albemarlensis.—Genæ distinctly differentiated from rest of head, being paler and having a slaty color; thoracie markings as in the other two trinesiotic forms, but less distinct; tegminal maculations forming complete cross-bands as in the Charles and Barrington races of S. tetranesiotis.

From Tagus Cove, Albemarle Island.

Sphingonotus tetranesiotis charlesensis.—Head and thorax pale rusty-brown, head paler than thorax, no bands on either; tegminal maculations form complete cross-bars; lower surface of hind femur with a dusky longitudinal band.

From Charles Island.

Sphingonotus tetranesiotis barringtonensis.—Very similar to the Charles form. Head and thorax uniform reddish-brown; tegminal maculations forming complete cross-bands; lower three fourths of

Proc. Wash. Acad. Sci., August, 1902.

posterior tibiæ continuously dusky, differing thus from the Charles and agreeing with the Chatham and Hood forms.

From Barrington Island.

Sphingonotus tetranesiotis hoodensis.—Head and thorax uniform reddish-brown; tegminal maculations confined to lateral sloping surfaces; lower three fourths of hind tibia continuously dusky; a longitudinal dark band on lower surface of hind femur as in *charlesensis*.

Closely resembles the Charles race in all except the dusky color on hind tibia, agreeing thus with the Barrington form, but differs from the latter in the longitudinal dark band on lower surface of hind femur.

From Hood Island.

Sphingonotus tetranesiotis indefatigabilensis.—General coloration similar to that of the Charles form, but more reddish; maculations of tegmina not forming continuous cross-bands; no longitudinal band on ventral surface of metathoracic femur.

From Indefatigable Island.

RELATIONSHIPS OF THE Sphingonotus RACES.

The two species of *Sphingonotus*, as characterized above in their varieties, differ from each other as follows: the *trinesiotic* forms have pale longitudinal bands on the angles of the pronotum, and the genæ differ in color from the rest of the head; the *tetranesiotic* forms have no markings on either the head or the thorax, and the genæ are uniform in color with the rest of the head.

If we compare the distribution of the races of Sphingonotus with that of the Galapagos races of Schistocerca, little similarity will be found between the two cases. They agree only in this: that all the varieties in each genus can be referred to two species, and that one race of one species lives on Chatham Island and one race of the other The characters of the varieties themselves give no on Charles. evidence in either species, of any one's being the ancestor of the others. On the other hand, there is nothing to oppose the supposition that Chatham and Charles Islands were respectively the original homes of S. trinesiotis and S. tetranesiotis. It is easy to imagine how the races on the other islands might have descended from forms on Chatham and Charles similar to those now found there. The geologic and climatic characters of the various islands point to Chatham and Charles as being the oldest inhabitable parts of the archipelago. Hence, we may suppose that these two islands were the first to be populated by representatives of the genus. Here they could have become dif-

ferentiated into the two species. Finally, by migration to the other islands—from Chatham to Indefatigable and Albemarle, and from Charles to Hood, Barrington and Indefatigable, the various races could have been produced.

DETAILED DESCRIPTIONS.

SPHINGONOTUS TRINESIOTIS sp. nov.

Distribution.—Chatham, Indefatigable and Albemarle Islands. The characters of its three varieties are as follows :

SPHINGONOTUS TRINESIOTIS CHATHAMENSIS var. nov.

From Chatham Island.

Description of the Type. Male .- Head pale clay-color, front clouded with minute dark punctations; genæ paler than the other parts : a black post-ocular stripe, with a narrow, pale longitudinal line above it. Dorsal surface of prozona same color as top of head; dorsal surface of the metazona dusky reddish-brown with a pale stripe on each side, continuous from the pale clay-color of the dorsum of the prozona, running outward and backward just within the angle of the lateral deflection of the metazona. Just below the lateral angle of the prozona, bordering the pallid dorsal area, a dusky stripe continuous with the post-ocular stripe of the head; below this a pale area, and below it a wide reddish-brown band inclined obliquely from behind, forward and downward; on the metazona this is continued less distinctly, with an inclination in the opposite direction, exactly as in S. trinesiotis indefatigabilensis; the upper stripe continues more faintly upon the metazona, bordering the pale upper lateral stripes; metazona between these two black stripes reddish-brown; both prozona and metazona, below the lower stripe, pale. Sides of mesothorax and metathorax pale clay-color, clouded with dusky. Lower surface of the thorax uniform pale yellowish. Prothoracic and mesothoracic legs pale reddish-brown with a few dusky spots. Metathoracic femora very pallid, each crossed externally by two oblique black areas which do not quite reach the lower lateral outer carina, the latter with five small black spots; posterior swelling of femur slightly more brownish than the rest; on the inner surface the large spots well marked, the lower part of the first running forward as a wide band to the anterior end of the femur; no ventral femoral stripe. Hind tibia black at the upper end, then surrounded by a short yellow band widest on the outer side, from this to the lower end continuously bluish-brown, darkest on the inner side; spines yellow basally, black-tipped. First two joints of

hind tarsus clay-colored, the terminal one light green, the claws green, black-tipped. Tegmina darker than the rest of the body, the sides marked by two large dusky blotches confined to the lateral sloping surfaces; apical part with small dark brown quadrate spots. Abdomen uniform pale yellowish clay-colored. Length of tegmina 19 mm.

Variations (17 specimens).-Thirteen of the specimens have the stripes of head and thorax as described for the type, although they vary much in distinctness. Four are so uniformly pale-colored that they show only the faintest indications of the stripes. None of them show the slaty genæ of the Indefatigable and Albemarle specimens, although a pale coloration of the genæ is a common characteristic. In many the diverging lateral stripes of the dorsum of the metazona show plainly, but in others they are either wholly wanting or are present as mere suspicions. Two specimens have the longitudinal angles of the closed tegmina, pale clay-colored, forming two very conspicuous posteriorly converging stripes of the same color as the entire dorsal surface of the closed tegmina-a marking characteristic of S. trinesiotis indefatigabilensis. In only three specimens do the lateral blotches of the fore wings encroach on the dorsal surface of the wings, and in none do they form complete transverse tegminal bands. All the specimens have the hind tibiæ closed like those of the type, or on the same pattern, the bluish tinge being generally lacking and the color simply brown or dusky. The degree of coloration varies considerably, but the specimens differ uniformly from those of any other island in having the lower three fourths to four fifths of the tibiæ continuously dark-In most of the specimens the spines are dusky basally, colored. instead of yellowish as in the type. The green color of the third tarsal joint also is not a constant character, this segment being generally the color of the first and second segments.

Length of tegmina of *male*, 12, 12, 13, 12 = 12 mm.; of *female*, 18, 18, 17.5, 17, 17.5, 18, 19, 18, 18, 19, 17 = 18 mm.

The color pattern of the *type* is almost exactly that of *S. trinesiotis indefatigabilensis*, but the markings are less distinct. The pale supra-post-ocular stripes of the head are continuous across the prozona with the diverging stripes on the angles of the metazona. It shows most highly developed the pattern faintly indicated upon some of the Albemarle specimens. The Chatham race is certainly more closely related to the Indefatigable form than to any other, but it strongly resembles the Hood race in being of a uniform, pale, reddish-brown color and in having the lower part of the hind tibia dusky. On the

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other hand S. trinesiotis indefatigabilensis and S. trinesiotis albemarlensis agree with each other and differ from all the others in having the genæ slate-colored. The Chatham specimens, however, very commonly have the genæ paler and more uniform in color than the rest of the head. It is readily conceivable that this race may once have had slate-colored genæ, and that, before this character was lost, the ancestors of the Indefatigable and Albemarle races left Chatham. The only Chatham nymph obtained is 16 mm. long and is marked in every way like the adults.

SPHINGONOTUS TRINESIOTIS INDEFATIGABILENSIS var. nov.

From Indefatigable and Seymour Islands.

Description of the Type. Male.-Head dark gray above; front dusky, pale reddish-brown about the bases of the antennæ; genæ with a very pronounced slaty color; a distinct black post-ocular stripe extending from the eye backward and almost imperceptibly upward. Antennæ colored as with other races. Pronotum mixed dusky and reddish-brown; on upper part of the sides of the prozona a distinct black stripe continuous in front with the post-ocular stripe and faintly prolonged posteriorly to the reëntrant angle of the posterior margin of the metazona; below this a lighter colored area, which on the prozona is pale slaty, on the metazona reddish mottled with black; below this a second distinct black stripe, inclined obliquely downward and forward on the prozona, downward and backward on the metazona; below this stripe both prozona and metazona uniform, pale rusty. Sides of mesothorax and metathorax mottled with red, slate, brown and black. Thoracic sterna, as in the specimens from the other islands, uniform pale. Fore and middle legs reddish-brown, spotted with black. Hind femora with two dark blotches on the inner surface from the upper to the lower carinæ, situated as in the other forms; no prominent longitudinal dark line below; a small spot below, opposite the lower end of the posterior inner blotch, and on the left femur in front of this a very inconspicuous dark longitudinal line; outer surface also with two blotches, these opposite those on the inner surface. Femur otherwise pale, yellowish, clay-colored except terminal enlargement which is reddish-brown. Hind tibia dark at the upper end, below pale yellowish on the outer side, brownish on the inner side, except just below the upper black area when yellow; spines black-tipped, bases yellowish. Tarsal claws yellow, black-tipped. Abdomen above rusty-brown with the anterior parts of the terga

dusky, below pallid mottled with gray, black and rusty. Tegmina with the horizontal and sloping surfaces strongly differentiated and contrasted in color, the former pale brownish-clay-color with a small median basal area dark brown, the latter strongly infuscated, anteriorly the color specially condensed into two, large, dusky, brown spots reaching from the lower margin of the wing to the upper margin of the lateral sloping surface, excluded abruptly from the horizontal dorsal surface; posterior part of tegmina pale, immaculate; veins and reticulations dark brown. Length of tegmina 19 mm.

Variations (14 specimens).—In color these specimens are in some respects an intensified form of the Albemarle race. The slaty color of the genæ strongly characterizes all but four specially reddish specimens. There is a horizontal post-ocular stripe reaching from the eye to the prozona and two prozonal stripes present in all, although they vary considerably in intensity on different individuals. The metazona varies from light yellowish-brown to reddish-brown. The prozonal bands are sometimes continuous upon the metazona and sometimes not. Whatever the color of the dorsal surface of the metazona is, the prozona is generally lighter in color and uniform with the head. There is almost no variation in the color of the metathoracic femora, the large black spots are generally well indicated, resembling those of the Albemarle form but are either discontinuous or but faintly indicated across the dorsal edge of each femur. The basal and middle blotches on the tegmina are in no case present on the upper horizontal surface of the closed wings. The plain pale color of this area contrasts strongly with the lateral surfaces, forming the most conspicuous character of the species, and one by which it is easily distinguishable in the field from the other species of the genus on the same island, with which it associates, viz., S. tetranesiotis indefatigabilensis.

The nymphs have the markings of head and thorax that are characteristic of the adults, the slaty genæ being prominent.

Length of tegmina of *male*, 14, 13, 13, 15 = 14 mm.; of *female*, 18, 19, 20, 19.5, 20, 18.5, 20, 20, 19.5, 18.5 = 19 mm.

This form is evidently more closely related to the Albemarle race than to either the Charles race or the other Indefatigable race. Although it differs from *Sphingonotus trinesiotis albemarlensis* in being somewhat larger, yet it resembles it and no other in the slaty color of the genæ, and the Albemarle race has faint indications of all the markings of the head and thorax of *S. trinesiotis indefatigabilensis*. The latter however differs distinctly from the former in the coloration of the tegmina.

SPHINGONOTUS TRINESIOTIS ALBEMARLENSIS

var. nov.

From Tagus Cove, Albemarle Island.

Description of the Type. Male.-General tone of coloration dull reddish-brown, everywhere more or less mottled or spotted with Top of head, frontal lunule, and frontal costa as far down as black. bases of antennæ, dusky, the frontal lunule mottled with orange; on each side of vertex a darker colored groove curving outward posteriorly; a narrow orange post-ocular stripe running backward and inward a little above the middle of the eye; genæ below this stripe pale slate-colored; clypeus and lower part of front spotted everywhere with black on a reddish-brown ground; labrum slaty, punctate with black. Antennæ dusky, each segment annulate with orange, this color especially prominent basally, the black predominant distally. Pronotum dusky on dorsal surface, above on each side an indistinct, orange stripe continuous in front with the narrower post-ocular stripe, posteriorly the two diverging to the outer posterior angles of the metazona; on the prozona below the orange stripe a wide black stripe on the lateral angle, next below this a narrower slate-colored stripe followed by a wider black stripe again; the rest of the prozona and the sides of the metazona reddish-brown with black mottlings and punctations. Sides of mesothorax and metathorax reddish-brown with small closely distributed black spots, making the general color dusky. Fore and middle legs reddish-brown, black spotted. Hind femora having a decidedly reddish tinge with a slaty tone along the outer side, each crossed above by two black bands reaching from the inner lower carina to the outer lower carina; on the outer side neither of these stripes is definitely outlined and each is obliquely inclined from above downward and forward; posterior enlargement of femur mottled with black giving it a dark appearance so that the femur appears marked with three transverse dusky areas. Hind tibia and tarsus yellowish, mottled with black, spines all black-tipped. Abdomen reddish-brown and slate mottled with black. Tegminal membranes pale transparent brown, color deepest basally, veins and reticulations dark brown; at about a third of the length of each tegmen from its base to the tip a large dusky blotch made up of numerous small fused spots; the blotches of the two tegmina meet above forming continuous cross-bands; half way between each of these spots and the tip of the tegmen a second small blotch confined to the side of the wing and of a brown color rather than black; beyond this numerous much smaller brown quadrate spots, and a few very small ones between the two large blotches. Posterior wings with

veins and reticulations all very dark-brown, membrane of anal half transparent with pink and green reflection, of humeral half rather strongly infuscated. Length of tegmina 17 mm.

Variations (13 specimens).-Many of the specimens are in general much paler than the type, and in the majority the stripes on the outer sides of the posterior legs are much less distinct. The maculation of the tegmina varies from brown to black. In nearly all cases the anterior black spots meet each other mesially, and in many the median spots also meet-in nearly all they approximate each other much more than in the type, or are connected by a lateral spreading of a condensation of the dorsal spots of the intervening area of the tegmina. Nine of the specimens have the slaty color of the genæ well marked as in the type, three of the others are everywhere very pale, while the fourth is unusually dark. The ventral surface of the thorax is in all the specimens pale, much paler than the lateral parts. The prozonal markings are best developed in the type; in the others the thorax is usually dull reddish-brown. In a few the small spots of the apical part of each tegmen are so crowded as to form a third dusky area half way between the median blotch and the tip of the wing.

Length of tegmina of *male*, 12, 12, 11, 11 = 11.5 mm.; of *female*, 15, 16, 16, 17, 17, 16, 17, 16, 15.5 = 16 mm.

SPHINGONOTUS TETRANESIOTIS sp. nov.

Distribution.—Charles, Hood, Barrington and Indefatigable Islands. The characters of its four varieties are as follows:

SPHINGONOTUS TETRANESIOTIS CHARLESENSIS

var. nov.

From Charles Island.

Description of the Type. Male.—Head almost uniform and pale without stripes, somewhat dusky above and on the front; genæ lacking the slaty color. Pronotum pale yellowish-brown; metazona dusky along posterior margin; no sign of stripes on the side of the prozona. Sides of mesothorax and metathorax yellowish-brown; sterna of the same segments much paler than sides, being a pallid gray. Hind femora pale brownish on outer side with no trace of black bands, a few dusky spots along upper and lower carinæ, floor of ventral groove between the inner and median lower carinæ black except posteriorly where it is the color of the outer surface of the femur; inner surface with a large black area occupying nearly the anterior half of the femur, and a second smaller one occupying the position of the median black blotch of the Albemarle specimens, both fused below with the ventral black stripe. Hind tibia pale yellowish-brown, punctate with dusky-brown. Length of tegmina 17 mm.

Variations (38 specimens).—The Charles specimens differ but little in color from those from Tagus Cove, except that the genæ are invariably colored uniformly with the rest of the head, and the head and thorax wholly lack the stripes that are indistinctly present on some of the Albemarle specimens. The transverse bands of the hind femora are lacking but the outer surface of each is generally clouded more or less with black. The ventral femoral stripe is present on thirty-six specimens (the other two have lost both metathoracic legs). This character distinctly separates the Charles and Hood races from the others; a few of the Albemarle specimens have only a faint indication of this stripe. The maculation of the terminal part of the tegmina is in most of the specimens slight or obsolete; on the other hand the two large blotches are generally very distinct and in most cases form two complete cross bands.

These figures show that the Charles form is larger than that from Tagus Cove or Albemarle, and their larger size is apparent when they are seen in the field.

SPHINGONOTUS TETRANESIOTIS BARRINGTONENSIS var. nov.

From Barrington Island.

Description of the Type. Male.—Head and thorax uniform pale reddish-brown, no dark markings anywhere. First and middle legs of same color as the body, spotted with black. Outer surface of hind femur pallid with faint indications of dark cross bands, inner surface as in the other races, *i. e.*, with a large elongated black spot anteriorly and a smaller one back of the middle; no ventral stripe on the femur. Posterior tibia colored as in the Chatham and Hood races; second and third joints of the tarsus green. Tegmina brownish, with two complete cross bands; terminal maculations few. Length of tegmina 17 mm.

Variations (9 specimens).—The Barrington specimens differ from the Hood specimens in the paler tegmina on which the dark basal and median blotches form two well-defined cross bands. The specimens present only a small amount of variation. One has a post-ocular stripe on each side of the head; otherwise there is no indication of

any stripes on either the head or the thorax. The posterior tibiæ are in all cases colored as in the *type*, agreeing in this respect with both the Chatham and the Hood races. In most of the specimens the hind femur has a more or less distinct dark ventral band. It runs forward a varying distance from the lower part of the posterior large spot on the inner surface. In this respect the specimens resemble those from Charles Island.

Length of tegmina of *male*, 13 mm.; of *female*, 18, 17.5, 17.5, 17, 17, 18, 15, 18 = 17 mm.

SPHINGONOTUS TETRANESIOTIS HOODENSIS var. nov.

From Hood Island.

Description of the Type. Male.—General coloration very uniform reddish-brown, head and thorax scarcely differentiated in color, dorsal part of metazona a little darker than the other parts. Fore and middle legs almost uniform, spots indistinct. Hind femur pale externally with a few small scattered spots and a row of spots along the lower outer carina; the interior surface with two black blotches of similar position as in the other forms, the anterior elongated, reaching the trochanter; terminal swelling dusky on inner side; a dusky line along the floor of the ventral groove between the inner lateral and ventral median carinæ. Posterior tibia and tarsus colored exactly as in the Chatham type. Tegmina same color as body; large blotches reduced in size and generally indistinct; smaller quadrate maculations very small and scattered. Abdomen slaty, mottled with dusky; the terga bordered posteriorly with orange. Length of tegmina, 20 mm.

Variations (10 specimens).—In color the specimens from Hood Island are very dark dull reddish-brown, resembling in this respect S. tetranesiotis indefatigabilensis, and have all the markings reduced to a minimum, the whole body being nearly uniform. The genæ are colored the same as the rest of the head Some show the very faintest indications of stripes on the thorax and head, forming the same pattern as in S. trinesiotis. Three of them lack the posterior orange borders of the abdominal terga described for the type. They all agree with the type, however, in the coloration of the hind tibia and many have the terminal joint of the tarsus greenish. The continuous infuscation of the lower two thirds of the hind tibia is a character possessed by the trinesiotic Chatham race, and by the tetranesiotic Hood and Barrington races, but not by any of the others. This character might, therefore, be taken as evidence of a relationship between these three.

to the Charles form, and their otherwise dissimilarity to the Chatham form, is probably of more importance than the single character of the color of the hind tibia. All of the Hood specimens have the dark ventral femoral stripe as in the type, a character shared only with the Charles race.

Length of tegmina of *male*, 14, 15, 14 = 14.3 mm.; of *female*, 20, 19, 18, 18, 17, 19 = 18.5 mm.

SPHINGONOTUS TETRANESIOTIS INDEFATIGABIL-ENSIS var. nov.

From Indefatigable and Seymour Islands.

Description of the Type. Male.—Differs from the Charles type as follows: general tone of coloration reddish, no dusky on the head except at lower border of the front. Basal parts of the tegmina with a strong reddish tinge, the lateral blotches confined to the sloping lateral surfaces of the closed tegmina, leaving the dorsal flat area plain except for a few maculations posteriorly between the posterior lateral blotches. No dark line on the ventral surface of the femur.

Length of tegmina, 18 mm.

Variations (23 specimens).—These specimens differ conspicuously as a group from those of either Albemarle or Charles islands in having in general a much more ruddy tone of coloring. They also lack, almost entirely, the ventral black femoral stripe, some having, however, a very faint indication of it.

Length of tegmina, of *male*, 13, 14, 14.5, 12.5, 14, 14, 13, 12.5 = 13.4 mm.; of *female*, 20, 18, 20, 20, 19, 20, 19, 19, 19, 20, 19, 18, 19, 20, 19 = 19 mm.

These figures show that there is no difference in size between the Charles race and this variety. The two forms are certainly closely related especially in the uniform coloration of the head and thorax, while the hind femora almost duplicate each other in the two cases, except for the ventral stripe present on the Charles form but absent in the other. Another very well-marked distinction, although not quite so constant, is the separation, along the median line, of the black blotches of the tegmina; in only three specimens do they form complete cross bands.

Genus Halmenus.

GENERAL REMARKS.

Halmenus Scudder, Bull. Mus. Comp. Zoöl., xxv, p. 17, 1893.

Type Halmenus robustus (Indefatigable and James Islands, Galapagos).

This genus has heretofore been reported only from Indefatigable

and James Islands. It occurs, however, also on Wenman, Charles and Albemarle. Each of the last two islands adds a new species to the genus, and it is probable that a search at the proper season on the other islands would show that the genus is not limited to the five islands from which it is now known.

H. robustus was found abundant early in June on that part of Indefatigable adjoining the Seymour Islands. Only one specimen of H. choristopterus was obtained on Charles. On Albemarle, one specimen of H. cuspidatus was obtained in December at Iguana Cove, a very humid district. The other specimens were taken in June near the top of the high mountain inland from Tagus Cove. The species was found here only above 3,500 feet, but below the summit—4,000feet. This region is wetter than the lower parts of the mountain, but it is arid compared with the Iguana Cove region, and much dryer than the summit of the mountain. Hence, the distribution of the species is somewhat curious. The Wenman specimen is interesting in being the only Orthopteran secured on the island. It was taken from the stomach of a mocking bird.

DETAILED DESCRIPTIONS.

HALMENUS ROBUSTUS Scudder.

Pezotettix vic. sp. BRUNER, Proc. U. S. Nat. Mus., XII, p. 193, 1889. Halmenus robustus Scudder, Bull. Mus. Comp. Zoöl., XXV, No. I, VII, p. 18,

pl. 1, figs. 6 and 7, 1893.

From Indefatigable and James Islands.

Description of Eight Specimens .- Head and dorsum of pronotum brownish-yellow, the frontal costa in four specimens dotted above with fuscous along the lateral angles; in one the whole front, vertex and genæ are coarsely spotted with black, and there is much continuous dusky about the bases of the antennæ; a black longitudinal postocular stripe. Antennæ generally irregularly annulate with dusky on a yellow ground, the dark color sometimes occupying a whole segment and sometimes only a part of a segment, generally more prominent on the distal half where its tends to become continuous; two specimens have no dusky on the basal part of the antennæ; antennæ hence not concolorous as described by Scudder. Eyes dark brown. Upper part of the side of the prozona with a wide longitudinal black band, generally with a yellow longitudinal dash in it on the scutum; the prozona below this stripe either plain brownish-yellow or with black spots and mottlings. The specimen having the entire head spotted with black has also the entire dorsal surface of the pronotum mottled with the same color, and the sides below the lateral stripe spotted as is the head. The black band of the prozona in four specimens continues unbroken across the metazona becoming, however, on the metazona oblique, extending downward as well as backward. On three specimens it is faintly marked as streaks and spots across the metazona, while on one it ends abruptly on the interior end of this sclerite. Six specimens have two round black spots on the dorsal surface of the pronotum on the suture between the prozona and the metazona. One has only one very small one and this only on the left side, and the spotted specimen has them obscured by the other dark markings. Five have a similar pair of spots on the middle of the dorsal surface of the præscutum. There is no "bright white broken and bent stripe" below the lateral black prozonal band, as described by Scudder, on any of the specimens although such a stripe is present on the Charles Island specimen. The tegmina vary considerably. In two specimens the dorsal surface has the same color as the dorsal surface of the pronotum-brownish-yellow-with small dusky blotches, and the lateral surface mottled black and brown. Five specimens have the dorsal surfaces brown and the lateral surfaces black or dusky-brown. The eighth has the dorsal surfaces yellowish-brown and the lateral surfaces blackish-brown. Fore and middle legs yellowish, spotted with black. Posterior femur with basal, premedian, postmedian and apical transverse black bands reaching over the dorsal surface from the lower inner carina to the lower outer carina, the lateral parts of the first three being inclined obliquely forward from above. The rest of the femur brownish-yellow, spotted with black; a row of small quadrate black spots along the lower outer carina. Tibia and tarsus yellowish, spotted with black, claws black, the tibial spines black-tipped. Most of the specimens have the abdomen brownish below, yellowish above, with the second to eighth terga inclusive having large black blotches on the sides. In one the general color of the abdomen is reddish-brown and the black spots meet above forming continuous black bands covering the anterior two thirds of each tergum. In another the whole abdomen is brownish, below darker and with a reddish tinge; all of the first segment and the lateral parts of the second to eighth segments are black.

MEASUREMENTS OF HALMENUS ROBUSTUS EXPRESSED IN HALF MILLIMETERS.

s	Ma	le.			Average.						
						Male.	Female.				
Length of	body.	55	56	70	71	69	61	58	55	55.5	64
" "	tegmina.	15	14	21	18	17	15	15	13	14.5	16.5
""	prozona.	7	7.5	10	9	8	8	8	8	7.2	8.5
" "	metazona.	5.5	5.5	7	6.5	7	6	6	5.5	5.5	6.3

HALMENUS CHORISTOPTERUS sp. nov.

Distribution.-Charles Island.

Description of the Type. Female.—Differs very markedly in the following structural characters from all of the Indefatigable specimens of *H. robustus*. Tegmina relatively very small and widely separated, reaching only slightly beyond the second abdominal tergum; their posterior ends rounded, lateral margins symmetrical. Pronotum strongly carinate mesially and latero-dorsally, lateral ridges not so sharp as the median.

General color yellowish-reddish-brown, much darker than in H. robustus. Black prozonal band not continued upon the metazona; a yellowish-white stripe borders the black prozonal band inferiorly; the whole of the lateral lobes of the pronotum below this stripe rugose, mottled with reddish and yellowish-white. Tegmina brown bordered laterally with white. One specimen of H. robustus has the right tegmen bordered with pale brownish near the base. Abdomen brown with small black blotches along the sides of the terga. Black bands of the posterior femora but faintly indicated, almost obsolete on the outer sides.

The *type* is the only specimen obtained. Its measurements are: length of body 34; tegmina 4.8; prozona 4; metazona 3.5 mm.

HALMENUS CUSPIDATUS sp. nov.

Distribution.—Albemarle Island; Iguana Cove at sea level; Tagus Cove between 3,500 and 4,000 feet.

Description of the Type. Female.—Much resembles the Charles type of H. choristopterus but differs in its much smaller size and in much more acute angle which the front forms with the vertex, this latter character being very conspicuous, the angle being about 55 degrees, while in H. robustus and H. choristopterus it is about 75 degrees. Tegmina well separated along the median line, narrow, reaching little past the second abdominal tergum. Pronotum mesially carinate; lateral angles not quite so prominent as in the Charles type, much more so than in H. robustus.

Head dark reddish-brown; front dusky; a black post-ocular stripe narrowly and faintly margined above with yellow. Antennæ annulate with black and yellow basally, mostly dusky on the distal half. Dorsum of prozona same color as the head; a wide lateral black prozonal band as in other forms, below which a light yellow line, and below this, on both the prozona and the metazona to the lower margin of the pronotum, yellow punctate with brown and with a large black spot on the scutum. Entire metazona, to the lower yellow band, color of head and dorsum of the prozona. Tegmina brown with very faintly pale outer margins. Hind tibia and abdomen the same as in the type of H. choristopterus except that the lateral abdominal blotches are slightly larger.

Length of body, 25 mm.

Variations (7 specimens).—All the specimens have a median dorsal carina on the pronotum, and all have a more or less prominent lateral angulation to the pronotum. They differ uniformly from the Charles and Indefatigable species in having the much more receding front as in the type.

In color they vary little from the type. Some have the general color a little lighter brownish, and two of the males lack the brighter upper yellow stripe just below the lateral black prozonal band. One has three very distinct oblique dark bands on both the outer and inner sides of the hind femora, but in none do they cross the dorsal surface of the femur. The tegmina of all agree with those of the type, except that two have the outer pale marginal bands very distinct.

MEASUREMENTS OF HALMENUS CUSPIDATUS EXPRESSED IN HALF MILLIMETERS.

	jex.	Ma	ıle.		F	Ave Male.	rage. Female			
Length of	body.	53	49	41	43	39	40	42	51	41
"	tegmina.	10.5	8	8	9	5	7	IO	9.2	8
44	prozona.	6.5	7	5.5	5.5	5	5.5	5.5	6.75	5.4
""	metazona.	5	4.5	4.5	4	4	4	4	4.75	4

HALMENUS sp.?

From Wenman Island.

Very similar to H. choristopterus of Charles. Wings separated even more widely than" in this species, each somewhat narrowed at the base and expanded distally. Colors not well preserved, but apparently the same as in H. choristopterus, except that the tegmina do not have white outer margins.

One mutilated specimen taken from the stomach of a Wenman mocking bird. The Halmenus must have been captured by the bird on this island, for this mocking bird is peculiar to Wenman and the far distant Barrington Island. It is not probable that the birds go back and forth between these two islands, crossing other islands that have peculiar species.

PLATE XXVI.

Diagrammatic illustration of apparent relationships of varieties of *Schistocerca* on the Galapagos Islands.

(452)

PLATE XXVI.



RELATIONSHIPS OF THE VARIETIES OF SHISTOCERCA IN THE GALAPAGOS ISLANDS.



Proc. Wash. Acad. Sci., Aug. 1902.

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PLATE XXVII.

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Varieties of Schistocerca on the Galapagos Islands.

Natural size. Drawn by Miss Mary H. Wellman.

FIG. 1	ι.	Schistocerca	melanocera, female. Charles Island.
:	2.	"	intermedia borealis, female. Abingdon Island.
	3.	" "	intermedia, female. Duncan Island.
4	4.	" "	literosa discoidalis, female. Chatham Island.
	5.	"	melanocera lineata, female. Iguana Cove, Albemarle Island.
	6.	"	melanocera immaculata, male. Indefatigable Island.

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VARIETIES OF SHISTOCERCA ON THE GALAPAGOS ISLANDS.



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PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

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PAPERS FROM THE HOPKINS STANFORD GALAPAGOS EXPEDITION, 1898–1899.

Х.

ENTOMOLOGICAL RESULTS (8).

MALLOPHAGA FROM BIRDS.

BY VERNON L. KELLOGG AND SHINKAI I. KUWANA.

STANFORD UNIVERSITY, CAL.

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INTRODUCTION.

THE first collection ever made of the parasitic insects Mallophaga (biting lice) found on the birds of the Galapagos Islands is that made by Mr. Snodgrass in 1898–1899 and here reported on. The collection includes specimens from 183 birds and represents 34 out of the 79 species of birds. Parasites were taken from 26 of the 48 bird species and all of the five bird genera peculiar to the Galapagos. This enumeration of bird species is based on the work of Rothschild and Hertert.¹ To their list Snodgrass and Heller have added at least three species. The last published list of Galapagos birds, prior to Roths-

¹Novitates Zoologica, Vol. v1, pp. 85-205, August, 1899. Proc. Wash. Acad. Sci., Sept., 1902.

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child and Hertert's is one by Ridgway,¹ whose list includes 105 species. Ridgway's longer list of species results from regarding as species some forms classed by Rothschild and Hertert as varieties. The whole number of species of Mallophaga in the collection is 43, of which 25 are new to science and are here first described. Of the 18 species determined to be identical with previously known forms, three are represented by specimens which differ so considerably from the types that they must be referred to as varieties. As most of the species to which the Galapagos Island forms can be referred have been previously described by the senior author from birds of North and Central America, the types were available for comparison and no doubts as to the determinations need be entertained.

It was hoped that the character of the parasites found on the strictly Galapagos Island bird hosts might throw some light on the relationships of these birds to continental genera and species, but our knowledge of the distribution of the Mallophaga is yet far too meager to give much value to suggestions in such direction and especially as we have no data at all regarding the Mallophaga of birds from the west coast of South America, from which region the Galapagos Islands doubtless received most of their original fauna. Moreover, an extraordinary condition referred to in the next paragraph, attending the distribution of the parasites among the birds of the islands, made such an attempt even less profitable than it might otherwise have been.

When the authors first began the examination of these Mallophaga they were startled by the unusual eccentricity of the occurrence of the parasites on the various bird hosts. A species of Mallophaga, obviously normal in such a strictly land bird as *Geospiza* would be found to occur occasionally on such strictly maritime birds as terns. For example, *Nirmus vulgatus*, a typical parasite of passerine birds, and heretofore found only on them (twenty passerine hosts previously recorded by Kellogg) occurs abundantly on *Geospiza*, *Nesomimus* and *Camarhynchus* and was also found on *Sterna fuliginosa* (Clipperton Island). On the other hand a common *Nirmus* of *Sterna* and *Anous* (*Nirmus gloriosus*) and belonging to a group of *Nirmi*, the

¹ Proc. U. S. Nat. Museum, Vol. XIX, pp. 459-670, 1896.

MALLOPHAGA FROM BIRDS

nigropicti, abundant on terns and gulls and normally peculiar to these ocean birds was taken also on Geospiza, Camarhynchus, Nesomimus and Progne. The first cases of this kind met with in working over the collection were attributed to mistakes in the collectors' records, or to straggling after death when the birds' bodies were in occasional contact in the game bag or on the skinning table. But the repeated occurrence of these extraordinary conditions and the testimony of the collectors soon revealed the true cause of this unusual distribution. We have to do with an abnormal phase of normal straggling! On the rocks of the islands maritime and land birds sit closely huddled, actual contact of the bodies often occurring. Migration is easily effected, and thus a parasite species (Colpocephalum unciferum Keel) normally peculiar to pelicans finds its way to a warbler (or honeycreeper), Certhidea. Thus are explained the large number of unusual and startling instances in the host distribution of the Galapagos Island Mallophaga.

Certain facts of interest connected with the parasites found on the bird genera peculiar to the archipelago, should be touched on. Geospiza fuliginosa has a total of twenty Mallophagous species credited to it, the largest recorded list of Mallophaga from any bird species. Four or more parasitic species are recorded from each of 18 of the 34 bird species from which Mallophaga were taken; a condition unique in the records of collections of Mallophaga. This condition, of abundant parasitism, is, of course, also due to the unusual facility of migration (or normal straggling) afforded by the forced gregarious habits of the islands' birds. A fair number of the bird species peculiar to the archipelago are infested by parasitic species not hitherto known, and thus will lend a special interest to any collections of Mallophaga which may be made from birds of the west coast of South and Central America, the region from which the bird fauna of the islands has been derived. It is of interest to note the marked commonness of parasitic species to the genera Geospiza and Camarhynchus, thus lending weight to the belief in their very near relationship. However there is at present, as already said, little of real value to be got from such speculation. A considerable number of the species in this collection

are confined to hosts which are peculiar to the islands; but as so much opportunity for miscellaneous migration is offered, these forms cannot be advantageously compared with other species whose individuals may have actually recorded a wider host range but are also normally peculiar to strictly Galapagos hosts.

A second collection of Mallophaga from Galapagos Islands birds is now being made by Mr. Beck and with this additional material, and with collections from the west coast of South and Central America in hand it may be that some generalizations of importance may be arrived at.

The names of the birds used in this paper are those adopted by Ridgway¹ because these names were used by Snodgrass and Heller in determining the birds.

The papers by Kellogg on North American Mallophaga which are constantly referred to by abbreviated titles in the following pages are the following :

- New Mallophaga, I; Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University, No. IV, 1896.
- New Mallophaga, II; Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University, No. VII, 1896.
- New Mallophaga, III; Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University, No. XIX, 1899.
- A List of the Biting Lice (Mallophaga) taken from Birds and Mammals of North America, Proc. U. S. Nat. Mus., Vol. XXII, pp. 39-100, 1899.

The authors have to express their obligations to Professor Walter Miller, of Stanford University, for assistance in composing the specific names, and to Miss Mary Wellman, artist.

SYSTEMATIC ACCOUNT.

Genus Docophorus.

DOCOPHORUS VALIDUS MINOR var. nov.

KELLOGG AND CHAPMAN, New Mallophaga, III, p. 56, pl. v, fig. 2, 1899.-KELLOGG, List of Mallophaga, p. 44, 1899.

Four specimens, male and female, from *Puffinus subalaris* from ¹ Proc. U. S. Nat. Museum, Vol. XIX, pp. 459-670, 1896.



Snodgrass, R. E. 1902. "Papers from the Hopkins Stanford Galapagos expedition, 1898-1899. viii. Entomological Resultes (7) Schistocerca, Sphingonotus and Halmenus." *Proceedings of the Washington Academy of Sciences* 4, 411–464. <u>https://doi.org/10.5962/bhl.part.18574</u>.

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