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**Protective resemblance borne by certain African insects to the blackened areas caused by Grass Fires**



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## Protective resemblance borne by certain African insects to the blackened areas caused by Grass Fires.

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(With Plate 11.)

The susceptibility of many Lepidopterous larvae to the colours of their normal surroundings is well known; also that of numerous exposed butterfly pupae, the determining stimulus operating upon the larva as it rests upon the surface to which the pupa will be attached.

The resemblances of certain mature insects to their surroundings, such as the weevil *Cleonus sulcirostris* to sands of different tints in different localities (Trans. Ent. Soc. Lond., 1899, p. 430), or the moth *Gnophos obscurata* to the dark of peat and the pale background of chalk (ibid., 1892, p. 453), may probably be due to special susceptibility to stimulus, but until this is proved the effects of the local operation of natural selection must not be lost sight of. This latter interpretation seems to be undoubtedly valid for the darkening of several species of moths in the Lancashire and Yorkshire districts and the areas to the N. E. over which their smoke is carried by the prevalent winds (Poulton, Essays on Evolution, Oxford, 1908, pp. 308-10 and references).

These latter changes are in some respects similar to those which form the subject of this paper, especially in that the effect is due to human interference with the surroundings. An essential difference is seen in the regularly repeated seasonal interference due to the ancient native custom (p. 438) of burning the grass and bush in the dry season. Another difference often observable follows from the fact that a grass-fire sweeps rapidly through the dry growth and leaves the stronger stalks scorched and charred, but standing. Many species are adapted to this environment not by developing a melanic form, but one in which the black and darkened straw-colour are combined. And similarly with the mixture of the darker tints of a burnt area with the bright green of the young grass which springs up at, or even just be-

foie, the beginning of the wet season. Examples of these characteristic patterns and colours will be found on later pages.

Before proceeding to describe the African insects collected on blackened areas, two sections of this paper are devoted to the evidence that certain *Acrididae* (grasshoppers) possess the power of adjusting their colours to the tints of their surroundings.

Evidence observed by W. J. Burchell in 1814 that the colours of certain S. African Orthoptera are adjusted to their surroundings.

A power similar to that possessed by many Lepidopterous larvae was clearly recognised in certain Acridians by Burchell and recorded in his M.S. catalogue of South African insects. Thus a translation of his note on a female of *Xiphocera*<sup>1)</sup> sp? *cinerascens* Stål (756 in the tabular statement printed on p. 435) is as follows:

„The whole body (including the eyes) is coloured like the stones and sand of the locality which it inhabits, and the colour does not alter. It lives in dry stony places, and is sluggish, leaping heavily.“

His conclusion is also emphasised by the name *chameleon* which he suggests for 755, 756 and allied forms. He is careful however to point out that these insects (like the caterpillars with a similar susceptibility to stimulus) are without the chameleon's power of changing its colour at any time and rapidly. Being sluggish and doubtless normally remaining in the same place for their whole life, one adjustment is probably generally sufficient for these grasshoppers. If however, the insects were transported to different surroundings at a not too advanced stage, a power of re-adjustment would, as with certain caterpillars, probably be manifested. It is to be hoped that Burchell's observations may inspire some naturalist to make the experiment.

The facts observed over a hundred years ago by this great naturalist are so interesting that I believe the opportunity of reading the extracts from his hitherto unpublished Catalogue<sup>2)</sup> will be welcome. The numbers in the first column represent the forms which Burchell believed to be distinct species, while those in the second column he believed to belong to the species indicated by the preceding number in the first column. It will be observed that 755 is recorded as cap-

<sup>1)</sup> Now known as *Lamarckiana*. One brown example of *L. cinerascens* (No. 29, p. 447) was collected by Swynerton from recently burnt grass.

<sup>2)</sup> Burchell's discovery has been briefly recorded in Trans. Oxf. Univ. Jun. Sci. Club, May 1921, p. 134, and in Trans. S. E. Union Sci. Soc., 1921, p. 8.

tured *in coitū* with 756. This arrangement is of great value because the specimens are represented by fragments, often small fragments, and sometimes only by the M.S. number on the pin. The destruction was doubtless wrought by insect pests during Burchell's South American travels in 1825—30. The determinations, so far as they were possible with such material, are recorded in the fifth column. They were arrived at, after much careful study in the British Museum, by my friend Dr. G. A. K. Marshall, C. M. G., D. Sc., F. R. S. The specimens indicated by an asterisk were also submitted to my friend Sen. Don Ignacio Bolivar, who in every instance agreed with Dr. Marshall. The spelling of Burchell's localities in the fourth column was sometimes rather different from that adopted in the map of his classical work „Travels in the Interior of South Africa“. In such instances the map has been followed.

Species distinguished by Burchell.	Considered by Burchell to be same species as the preceding number in the first column.	Dates of capture in 1811—1815.	Burchell's localities and Notes.	Determinations by G. A. K. Marshall. The asterisk indicates confirmation by Ignacio Bolivar.
755		21. XI. 14	Zoetemelks River. — <i>A. chameleon</i> mas. Est foemineâ nigrior. Cum sequente (756) in copulatione captus.	<i>Xiphocera</i> ( <i>Lamarckiana</i> ) sp.? <i>cinerascens</i> Stal.*
	756	21. XI. 14	<i>A. chameleon</i> foem. Anus recurvus. Totus (etiam oculi) gaudet colore non mutante, petrorum et sabulae loci quem habitat. Hab. in petrosis aridis. Segniter saltans. Parum animatus.	Very fragmentary. The determination rests on Burchell's statement that 756 is the female of 755.
757		23. X. 14	Mossel Bay.	<i>Xiphocera</i> ( <i>Lamarckiana</i> ) sp.? <i>cinerascens</i> Stal.*
758		16. I. 15	Mountains at Zwelldam. <i>Chameleon</i> .	" " *
	759	3. XII. 14	Mountain Station. — <i>Chameleon</i> mas. N. B. Semper fuscus.	Very fragmentary. Determination impossible.
760		3. XII. 14	Mountain Station. — <i>Graminei</i> coloris.	Number alone on pin.

Species distinguished by Burchell.	Considered by Burchell to be same species as the preceding number in the first column.	Dates of capture in 1811—1815.	Burchell's localities and Notes.	Determinations by G. A. K. Marshall. The asterisk indicates confirmation by Ignacio Bolivar.
761		21. XII. 14	Krombeks River (near).	Condition as 759.*
	762	3. XII. 14	Mountain Station.	Number alone on pin.
763		1. XII. 14	Mountain Station. — <i>Chameleon</i> . Cinereus inter petra cinerea. Thorax acutissime carinata.	" " " "
764		4 p. m. 14. XI. 11	5 miles S. of Groote Fonteyn, near Klaarwater [Griquatown].	Condition as 759.
	765	16. XII. 12	Little Klibbolikhonni.	" " "
766		25. XI. 12	" "	<i>Xiphocera</i> ( <i>Hoplolopha</i> ) sp. nr. <i>dromadaria</i> Sauss.*; considered by Bolivar as synonym of <i>H. horrida</i> Burm. (Gen. Ins., Pamphagidae, 1916).
767		12 a. m. 13. XI. 11	Confluence of Ky Gariep. Cream-coloured.	Condition as 759.*
	768	p. m. 14. III. 14	Groote river in Lang Kloof. — Terrestriis. Cinereofuscus.	<i>Xiphocera</i> ( <i>Hoplolopha</i> ) <i>reflexa</i> Walk. = <i>camelina</i> Sauss.*
769		21. XI. 14	Zoetemelks River. — <i>Chameleon</i> foem. Segnis. Ano recurvo.	Number alone on pin.

The position of Burchell's localities has been kindly determined by Mr. J. H. Reynolds, Secretary of the Permanent Committee on Geographical names, of the Royal Geographical Society. „Mossel Bay“ remains unchanged; „Zwellendam“ is the modern Swellendam.

Zoetemelks River. — Tributary of Kaffirkuijs R., about 7 m. S. E. of Riversdale.

Mountain Station. — About 10 m. N. W. of Riversdale and N. E. of Heidelberg.

Krombeks River. — Krambeks R., a tributary of the Duivenhoks R., about 4 m. S. E. of Heidelberg.

Groote Fonteyn. — Near Campbell, about 17 m. N. W. of the confluence of Vaal and Riet Rivers.

Little Klibbolikhonni. — About 8 m. S. of Kuruman.

Confluence of Ky Gariep. — Confluence of Vaal (Ky Gariep) and Riet (Burchell's Modder or Maap) Rivers. The river now known as the Modder is a tributary of the Riet about 45 m. E. of its confluence with the Vaal.

Groote River. — Upper waters of Kouga R., probably the site of Haarlem, about 25 m. N. of Cape Seal.

Probable adjustment of the colours of the  
European Acridian *Stauroderus bicolor* L.  
to the tints of its surroundings.

The following observations were made at the conclusion of the Zoological Congress at Berlin in 1901, when I joined an excursion to Heligoland and there observed that *Stauroderus bicolor*, which was extremely abundant, always matched the red-brown soil of the island, everywhere shewing through the thin grass and between the potatoes of the cultivated parts. Not a single green or pale brown specimen was seen. Bathing was not permitted from Heligoland, and for this purpose it was necessary to row three-quarters of a mile to a low sandy bank called the Düne. Here the surface was a pale sand with patches of a coarse strongly-growing grass. All the grasshoppers, which were of the same species as those of Heligoland, were coloured so as to be inconspicuous against the sand or among the grasses on the pale surface. Not a single dark-brown example was seen. It seemed worth while to illustrate the difference in appearance by the collection of a long series; and on August 19<sup>th</sup> my son and I captured 73, all dark reddish-brown, on Heligoland; on the following day 80 on the Düne. The majority of the latter were pale but several were partially tinted with green. The difference between the dark brown and pale grey has, in process of time, become almost obliterated by some change in the pigments, but the green of the Düne specimens, although dulled, is still distinctly visible<sup>3</sup>).

There is little doubt that these results, observed without a single exception in such large numbers, in two localities so near to each other.

<sup>3</sup>) These results have been briefly recorded in Poulton, „Essays on Evolution“, 1908, Oxford, p. 307.

point to the conclusion that the species possesses the power of adjusting its colours to those of its normal surroundings, although these may differ widely from one another.

The species was kindly determined by my friend Mr. B. Uva-rov, of the British Museum, who has given me very much help in other parts of this paper.

The resemblance of an African Acridian of the genus *Cannula* to the combination of tints exhibited by scorched and blackened grass-stems.

This beautiful example was exhibited to the Entomological Society of London on 6 Nov. 1912, by the late Mr. A. Bacot (Proc. Ent. Soc. Lond., 1912, p. civ). The specimen has now been presented to the Hope Department of the Oxford University Museum by my friend the captor, Dr. C. J. Martin, C. M. G., F. R. S., &c., who has kindly written the following account of the circumstances:

„I was walking back from the Eastern part of Angola to Benguella. The ‘grasshopper’ was observed flitting from stalk to stalk of the half-burnt grass whilst I was having lunch.

„I noticed that whenever it settled it appeared to disappear although but a few feet from my eyes. The piece of burnt grass is one of those it settled upon. I secured the grass and the grasshopper at the same time, in one grab.

„The locality was long. 15° E., lat. 13° S., the date between the 15<sup>th</sup> and 20<sup>th</sup> Sept. 1912, i. e. the end of the dry season.

„Over much of Africa the natives burn the grass at the beginning of the dry season. This habit I understand was observed by Herodotus, so the insects have had a few years to adapt themselves to burnt grass.“

The insect (represented on Pl. 11, fig. 5 and the scorched grass-stem in fig. 4) is a wonderful combination of black and scorched-straw-colour. The first and second pairs of legs, the antennae and the median dorsal surface are deep black, extending down the elytra as far as the end of the body. Beyond this the terminal section of the elytra is pale brown, transitional anteriorly into the blackened part. The curled and twisted condition of the terminal section is considered by Mr. Uva-rov to be certainly due to *post mortem* changes. The third legs are dark-brown, with the femora black for a third of their length from the base. On each side of the body below the black dorsal area, is a band of darkened straw-colour, including the eyes which are rather



deeper and redder in tint than the rest of the band. The under surface of head and thorax is black. The divisions of the body are inconspicuous and the whole effect is that of a cylindrical section of straw, with short pieces of pale-brown leaf attached. A similar form and combination of tints are exhibited by the piece of scorched straw on which the insect alighted.

Mr. B. Uvarov, who kindly examined the specimen and referred it to the genus *Cannula*, was unable to determine the species with confidence. He informs me that none of the British Museum series of this species shews any trace of a greenish tinge, but that Prof. Y. Sjöstedt<sup>4)</sup> observed that *C. linearis* is in life usually greenish or brownish-yellow, while specimens taken on burnt grass were dark-grey („dunkelgrau“).

My friend, Mr. A. W. Pickard-Cambridge, informs me that neither he nor Mr. Macgregor, the Ancient History Tutor at Balliol, can find any mention of grass-burning in Herodotus. He has, however, kindly directed my attention to „an account in Hannö's 'Periplus' (perhaps the middle of the 5<sup>th</sup> century B. C., perhaps earlier) of great flames seen at night on the mountains of the W. coast of Africa (probably Sagres or in the neighbourhood of Sherboro Sound); but it is only a conjecture of commentators that these were due to the burning of pasture, etc.

“Here are Hannö's words:

“So we sailed thence in fear and hot haste. After four days' voyage we sighted a land full of flames by night: in the midst was a towering fire, greater than all the rest and reaching, as it seemed, the very stars. By day this appeared to be a very great mountain, called the “Chariot of the Gods”. Having sailed past streams of fire for three days, we came to a bay called “the Horn of the South” . . . .”

An explanation based on volcanic action appears to be out of the question, especially so in Africa, and Dr. G. A. K. Marshall agrees with me that the account might well be taken as „a rather exaggerated description of a bush fire“.

The evidence which would enable us to decide whether the species of *Cannula* possess the power of colour-adjustment in obedience to stimulus is not yet complete. Mr. Swynnerton's experiments shew that two examples of *C. linearis* (No. 4, p. 443), taken on recently burnt grass, exhibited the same combination of tints as Dr. Martin's specimen (p. 438), but these may have belonged to a seasonal form which

<sup>4)</sup> Arkiv f. Zoologi, Bd. 15, No. 21, 1923, p. 4.

appears at the time when the grass is burnt. The strongest indications are those of Prof. Sjöstedt; for if the brownish-yellow and dark-grey specimens (p. 439) were found on the appropriate surfaces at the same season the power of colour-adjustment in response to stimulus can hardly be doubted.

Dr. G. D. H. Carpenter's observations on the resemblance of African insects, including a Pentatomid bug and a caterpillar, to burnt wood and grass.

The following note, and several others published in Proc. Ent. Soc. Lond., 1925, pp. liii-lviii, were received in letters written by my friend Dr. Carpenter from Uganda in May and June 1925. The Pentatomid is briefly referred to on pp. lv, lvi.

„Orthoptera (e.g. Mantids and Acrididae) are not uncommonly found coloured coal-black like stumps of burnt grass after fire has passed over the land. I can remember a grasshopper which was most beautifully shaded and shaped to resemble the sharpened tip of a charred grass-stem. A horde of Noctuid larvae was found on Nsadzi island, L. Victoria, in 1914, feeding so ravenously on an area which had recently been completely burnt by fire, that the young grass-blades were being devoured almost more rapidly than they could be produced. These larvae were simply coloured in longitudinal stripes of coal-black and the brightest grass-green, and one or two among the charred stumps and new leaves on a grass tussock would be very well concealed<sup>5)</sup>.

„On May 19<sup>th</sup>, 1925 at Amua Camp, in the Gulu district of W. Madi, N. Prov. of Uganda, I found among grass the beautiful bug sent herewith, whose likeness to a partially burnt sharp-cornered chip of wood must, I think, be acknowledged. It was among stems of a tussock of grass. For comparison a common object of such burnt country (2 pieces of burnt stem of coarse grass found on the ground) is sent with it.“

The species (represented on pl. 11 fig. 3 and the pieces of burnt stem in figs. 1 and 2) was kindly determined by my friend Mr. W. E. China, of the British Museum (Natural History), as *Macrina juvenca* Burm. (Pentatomidae). The series in the British Museum shews a variable development of the blackened and charred-looking pattern in some of the specimens. It is probable that the black- and

<sup>5)</sup> See Dr. Carpenter's recently published „Naturalist in East Africa“, Oxford, 1925, p. 70.

-green-striped Noctuid larvae were those of *Spodoptera abyssinia* Guen. (Acronyctinae) with habits similar to those described by Dr. Carpenter. Dr. V. G. L. van Someren has given a graphic account of their numbers and destructive activities in Proc. Ent. Soc. Lond., 1925, p. xxxv. So far as I am aware Dr. Carpenter's is the first record of a burnt-grass-like pattern in Hemiptera and Lepidoptera. It is very probable that the caterpillars developed the characteristic pattern in response to stimulus.

Orthoptera (chiefly Acridians) collected by Mr. C. F. M. Swynnerton from recently burnt grass and other surfaces at Chirinda, S. E. Rhodesia.

In 1913 my friend Mr. Swynnerton kindly responded to my wish and made the large collection tabulated below. All the species but one have been kindly determined and the new ones described by Mr. B. Uvarov<sup>6</sup>). The single exception, the Blattid, was kindly determined by my friend Dr. R. Hanitsch, Ph. D. All the specimens were taken between 20 and 24 October on three types of surface in the same locality: I. Recently burnt grass; II. Grass burnt about four months earlier; III. Old grass, dry and yellow. It may be safely assumed that the first surface was the darkest, the third the lightest, and the second, in consequence of fresh growth, intermediate.

The reader will be able to judge how far there is evidence for susceptibility to some stimulus associated with the surroundings in any of the species here tabulated. Among the Acridians it is, I think, very difficult to reject the hypothesis of the existence of this susceptibility in species such as 10, 11, 12, 17, 19 and 42. The attempt has been made to render this evidence to some extent available by reproduction from photographs on pl. 11 figs. 6-23 (No. 10), and figs. 24-32 Nos. 12 and 13). Furthermore, since the grass in I had been burnt recently — probably not more than three or four days — the response to stimulus must be very rapid. Direct experimental evidence is much to be desired, but in the meantime it would be unreasonable to reject the conclusions clearly suggested by some of the long series of specimens in this abundant material.

Another interesting point emerges. The contrasted colours of *Ochrophlebia ligneola* (28) strongly suggest a warning pattern with distasteful qualities, and there is in this species no indication of colour-adjustment (see pl. 11 figs. 33-38); while the same uni-

<sup>6</sup>) Ann. Mag. Nat. Hist. (9). XVI. p. 630 (1925).

formity in the different surroundings with the same interpretation perhaps holds for the five species of *Cantantops* (30-34) with their-glistening brown colour diversified in parts with paler tints and with black.

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24. On recently burntgrass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
Blattidae. <i>Euthyrrhapha pacifica</i> Coq.	1			Deep black, with usual orange spots.
Mantidae. <i>Hoplocorypha</i> sp.	1			Entirely coal-black.
Gryllidae. <i>Scapsipedus</i> sp., larva.			1	Entirely very dark brown.
Tettigoniidae. <i>Phaneroptera reticulata</i> Br.-W., ♀.	1	1		Both brightgreen, becoming pale orange anteriorly.
<i>Tylopsis continua</i> Walk., ♀.	1	1		Very like <i>P. reticulata</i> , but legs pale brown.
<i>Xiphidion</i> sp., ♂.			1	Pale brown with darker head and dorsal area of prothoracic shield.
<i>Anarythropteris</i> sp., ♂.	1			Entirely medium brown.
Acrididae (nos. 1-46).				
1. <i>Phloeonotus jugatus</i> Walk.	2			Entirely dark brown, one being nearly black.
2. <i>Acrida crocea</i> Bol.	3	2	5	I. Faded green, becoming brownish anteriorly; legs pale brown.
				II. Green and deeper brown, also posteriorly on F. W.
				III. One similar to I, one to II; three with greater extension throughout dorsal area of same shade of brown.
3. <i>Acrida sulphuripennis</i> St.		1		Green, with brown antennae and legs.

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
4. <i>Cannula linearis</i> Sauss.	2			Black and darkened straw-colour, the latter far more extensive on the smaller specimen.
5. <i>Parga xanthoptera</i> St.	21	5	1	I. 8 black; 13 dark brown to light brown. II. 2 black; 3 dark brown. III. Rather lighter brown than any in I or II.
6. <i>Parga</i> sp.	3			Dark brown, black in parts, streaked with light brown.
7. <i>Paraparga</i> sp.,? <i>strigosa</i> Bol.	35	3	4	I. 11 very dark brown, nearly black; 24 varying from dark to light brown. II. All dark brown, one nearly black except legs. III. About the same as 4 lightest of I.
8. <i>Brachycrotaphus</i> <i>stuhmanni</i> Karsch.		3		Light brown streaked with dark, almost black in one specimen.
9. <i>Orthochtha dasycnemis</i> Gerst.		4	1	II. 3 brown, streaked with dark brown; 1 (immature) entirely rich brown. III. Lighter brown streaked with dark; side yellowish green, much lighter than any in II.
10. <i>Paracomacris deceptor</i> Karsch.	64	11	12	I. (See pl. 11, figs. 6—11) 30 black, or very nearly so, some with a very narrow yellow streak on side of elytra (along basal section of costa); 26 dark brown; 5 dull dark green dorsal area, 3 distinct deep green. The sides of these 8 are dark brown with lighter patches. The pale elytral

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
10. <i>Paracomacris deceptor</i> Karsch. (continued).	64	11	12	<p>streak present in some of the 26 and the 8 as well as of II and III.</p> <p>II. (See pl. 11, figs. 12—17) 2 dark brown, nearly black; 8 dark to lightish brown, the average distinctly lighter than the 26 in I; 1 green like the 3 in I.</p> <p>III. (See pl. 11, figs. 18—23) 10 exhibit shades of brown like the 8 in II but a still lighter average; 1 green, nearly as dark as the 5 in I but with lighter sides than any of the whole series.</p>
11. <i>Machaeridia conspersa</i> Bol.	9	12	10	<p>The whole series varies from dark to lightish brown, some specimens with pale dark-bordered lateral streaks, some with dorsal. The specimens in II and III are on the average distinctly lighter brown than in I.</p>
12. <i>Pseudochirista temporalis</i> St.	39		2	<p>I. 25 black or very nearly so; seen from above uniformly dark except for a brown patch near base of hind femur. Of the rest one has a pale brown dorsal area, while the others are dark brown, most of them very dark and hardly separable from the 25.</p> <p>III. (See pl. 11, figs. 31, 32). The two specimens resemble the least dark of the last-mentioned series.</p>

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I, Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
13. <i>Pseudochirista</i> sp., prob. <i>temporalis</i> St.	7			(See pl. 11, figs. 24–30.) Two specimens black, 3 black or dark brown with the pale dorsal area mentioned in no. 12, 2 black with an indication of a paler dorsal area.
14. <i>Gymnobothrus linea-alba</i> Bol.	31	5	3	All three categories exhibit transition from dark to light brown.
15. <i>Faureia milanjica</i> Karsch.	6	1		All dark brown with paler legs: a very uniform series.
16. <i>Phorenula gracilis</i> Uv.	20	6		I. 11 nearly black except for pale marks towards base of hind femur; 9 less dark, with a bright brown median dorsal stripe on thorax and head. II. 1 like 11; 1 between the 11 and the 9; 3 like the 9; 1 lighter than any, with the anterior brown of a brighter shade and continued as a pale stripe along the elytra.
17. <i>Pnorisa squalus</i> St.	12	2	5	I. 9 dark brown; 3 less dark. II. Both resemble the darkest of the above 3. III. 1 as above; 3 resemble the lightest of the 3 in I; 1 still lighter. The hind femora of all 19 are pale brown.
18. <i>Apnorisa fungosa</i> Bol.	1		22	I. The single specimen resembles the dark brown specimens in III. III. The series varies from dark to light brown.

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
19. <i>Ticra pictipes</i> Bol.	6	1	11	I. 4 darker brown (almost black) than any of series; 2 less dark. II. resembles the 2. III. 7 as the above; 4 a slightly lighter shade of dark brown.
20. <i>Gastrimargus africanus</i> Sauss.	10	6	2	I. 6 variegated shades of brown; 2 with the lighter shades replaced by dull green; 2 by brighter green. Mr. Swynnerton has noted that the 6 resemble scorched grass, the last 2 sprouting grass. II. 2 resemble the above 6; 4 (one immature and a rather duller green) resemble the last 2. III. 1 resembles the above 2 but is somewhat discoloured; 1 (immature) is almost black—probably <i>post mortem</i> discoloration.
21. <i>Ilumbe tenuicornis</i> Schaum.	1			Dark brown.
22. <i>Tmetonota abrupta</i> Walk.	2	2		All dark brown variegated with light, a uniform series.
23. <i>Morphacris fasciata</i> Thnb.	1		1	Both dark brown, I being rather darker, possibly <i>post mortem</i> .
24. <i>Heteropternis couloniana</i> Sauss	14			All are black, often variegated by pale brown, black-barred third femora, and in 3 by the pale brown posterior margin of the thoracic shield.
25. <i>Heteropternis</i> sp.		1		Resembles the less dark specimens of above species.



Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24 On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
26. <i>Acrotylus patruelis</i> H.-Sch.	20	7		I. Similar to the last species although a few are rather lighter. II. 4 resemble I, both shades being represented; 3 are rather lighter than any in the series.
27. <i>Trilophidia angustipennis</i> Kirb.	4			3 dark brown, 1 paler.
28. <i>Ochrophlebia ligneola</i> Serv.	10	3		(See pl. 11, figs. 33—35 and 36—38.) The contrast of broad black and orange (now somewhat discoloured) stripes on the visible parts of the body, and of similar narrow stripes on elytra and hind femora, strongly suggest the aposematic pattern of a distasteful species and in correspondence with this interpretation the series is uniform.
29. <i>Lamurckiana cinerascens</i> St.	1			Uniform medium brown.
30. <i>Catantops urania</i> Kirb	5		1	I. 2 females are of a rather darker brown than the 3 males. II. A male similar to the above three. The paler brown, black-barred hind femora are perhaps conspicuous in life.
31. <i>Catantops sulphureus</i> Walk.	7	5	1	The whole series a uniform medium brown dorsally, sharply demarcated from the very dark, anteriorly pale-barred lateral area. Hind femora rather paler than dorsal area.

Species of Orthoptera collected in 1913, at Chirinda, S. E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
32. <i>Catantops melanostictus</i> Schaum.	1	2		All very similar to the darker specimens of <i>C. urania</i> .
33. <i>Catantops decipiens</i> Karsch.	1			Very similar to the above.
34. <i>Catantops maculatus</i> Karny.	17	6	1	An extremely uniform series very similar to the last 2 species and <i>C. urania</i> .
35. <i>Anthermopsis comis</i> Karsch.	2	2	2	I. 1 pale green, including hind femora, becoming brown dorsally; 1 deeper green and the effect much darker. II. and III. Very similar to the paler in I, but one in each category with green thorax.
36. <i>Anthermus swynertonii</i> Uv.	4	1		Series uniform. A dark brown like the last 3 sp. of <i>Catantops</i> . Hind femora slightly paler with black marks barely visible.
37. <i>Eucoptacra pedestris</i> Uv.	2		1	I. Dark brown with pale brown hind femora. III. A much paler, redder brown.
38. <i>Tristria sudanensis</i> Karny.			13	Colouring very similar to <i>Catantops sulphureus</i> (31), but legs a pale brown. A very uniform series, a few being of a rather lighter shade of brown.
39. <i>Tristria pallida</i> Karny.	3	2	6	I. 1 similar to the above; 1 with slight development of greenish towards base of elytra; 1 with much stronger development and deep green median dorsal

Species of Orthoptera collected in 1913, at Chirinda, S.E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
<i>Tristria pallida</i> Karny (continued).	3	2	6	<p>line on thorax, continued on to head.</p> <p>II. 1 similar to last described; 1 brighter green also colouring the dorsal surface of thorax and head on each side of the median line.</p> <p>III. 1 similar to first of I; the remaining 5 show gradually increasing dorsal green, culminating in a specimen like the last of I.</p>
40. <i>Caloptenopsis fer-rifer</i> Walk.	5	1	1	<p>All very dark brown, the specimen in II and that in III slightly less dark than the average of the 5 in I.</p>
41. <i>Caloptenopsis mos-sambicus</i> Brancs.			2	<p>Both dark brown with pale margins uniting on the posterior half or two-thirds of the elytra.</p>
42. <i>Cataloipus rosei-pennis</i> Uv.	20		10	<p>I. 5 nearly black; 10 very dark brown with less dark margins as in last species; 1 similar but much paler margins; 3 uniform brown less dark than above, 1 intermediate.</p> <p>III. Much lighter brown than the average of I, the pale margins of 6 becoming tinged more or less deeply with yellowish green. These 10 are mature, whereas only 10 out of the 20 in I are mature. There is no reason to suspect that the comparison is vitiated. The 5 darkest as well as the 4 lightest in I are immature.</p>

Species of Orthoptera collected in 1913, at Chirinda, S.E. Rhodesia.	I. Oct. 20, 23, 24. On recently burnt grass.	II. Oct. 21. On grass burnt about 4 months earlier.	III. Oct. 22. On old grass dry and yellow.	Comparison of colours and shades of Orthoptera in I, II and III.
43. <i>Tylolotropidius gracilipes</i> Brancs.	5	3	8	An extremely uniform darkish brown series with no evidence of any effect due to the conditions.
44. <i>Ornithacris cyanea magnifica</i> Bol.			1	The date is given as Oct. 21 and perhaps should be Oct. 22. Dark brown with a pale dorsal stripe and pale bands on sides of elytra.
45. <i>Nomadacris septemfasciata</i> Serv.			1	General colouring similar to above.
46. <i>Mesopsis infuscatus</i> Kr.	1	2		I. Nearly black. II. 1 nearly as dark as above, 1 much less dark.

## Discussion:

G. F. van Bemmelen fragt, ob noch andere Fälle vom Auftreten und Zunehmen von schwarzen Formen auf Kosten der hellgefärbten, besonders von Gegenden, wo kein solcher Grund zum Schwarzwerden vorhanden ist, bekannt sind?

E. B. Poulton answers that black specimens are known from such districts, but that they are connected by transitions with the normal light-coloured form.



## Description of Plate.

Figs. 1 and 2. Burnt nodes of coarse grass such as are resembled by fig. 3.

Fig. 3. The Pentatomid bug *Macrina juvenca* Burm., captured, 1925, in N. Uganda by Dr. G. D. H. Carpenter. The combination of black and pale shades in the pattern resembles a scorched piece of wood or the charred node of a thick grass-stem.

Fig. 4. The charred grass-stem on which the insect represented in fig. 5 was captured.

Fig. 5. The Acridian (Grasshopper) *Cannula* sp. taken by Dr. C. J. Martin on the grass-stem shewn in fig. 4. Angola, 1912.

Figs. 6—23. The Acridian (Grasshopper) *Paracomacris deceptor* (10, on pp. 443, 444), taken under different conditions on nearly the same dates at Chirinda, S. E. Rhodesia, in 1913, by C. F. M. Swynnerton.

Figs. 6, 7, 8. The three darkest specimens on recently burnt grass: Oct. 24.

Figs. 9, 10, 11. The three lightest specimens on recently burnt grass: Oct. 24.

Figs. 12, 13, 14. The three darkest specimens on grass burnt about 4 months: Oct. 21.

Figs. 15, 16, 17. The three lightest specimens on grass burnt about 4 months: Oct. 21.

Figs. 18, 19, 20. The three darkest specimens on old grass, dry and yellow: Oct. 22.

Figs. 21, 22, 23. The three lightest specimens on old grass, dry and yellow: Oct. 22.

Figs. 24—32. The Acridian *Pseudochirista temporalis* and probably this species (12 and 13 on pp. 444, 445), taken under different conditions on nearly the same dates at Chirinda, S. E. Rhodesia, in 1913, by C. F. M. Swynnerton.

Figs. 24—30. All the seven specimens (No. 13) from recently burnt grass: Oct. 24.

Figs. 31, 32. The two specimens (No. 12) from old grass, dry and yellow: Oct. 22<sup>6</sup>).

Figs. 33—38. The Acridian *Ochrophlebia lignea* (28, on p. 447), taken under different conditions on nearly the same dates at Chirinda, S. E. Rhodesia, in 1913, by C. F. M. Swynnerton.

Figs. 33—35. Three examples of the uniform series taken on recently burnt grass: Oct. 20.

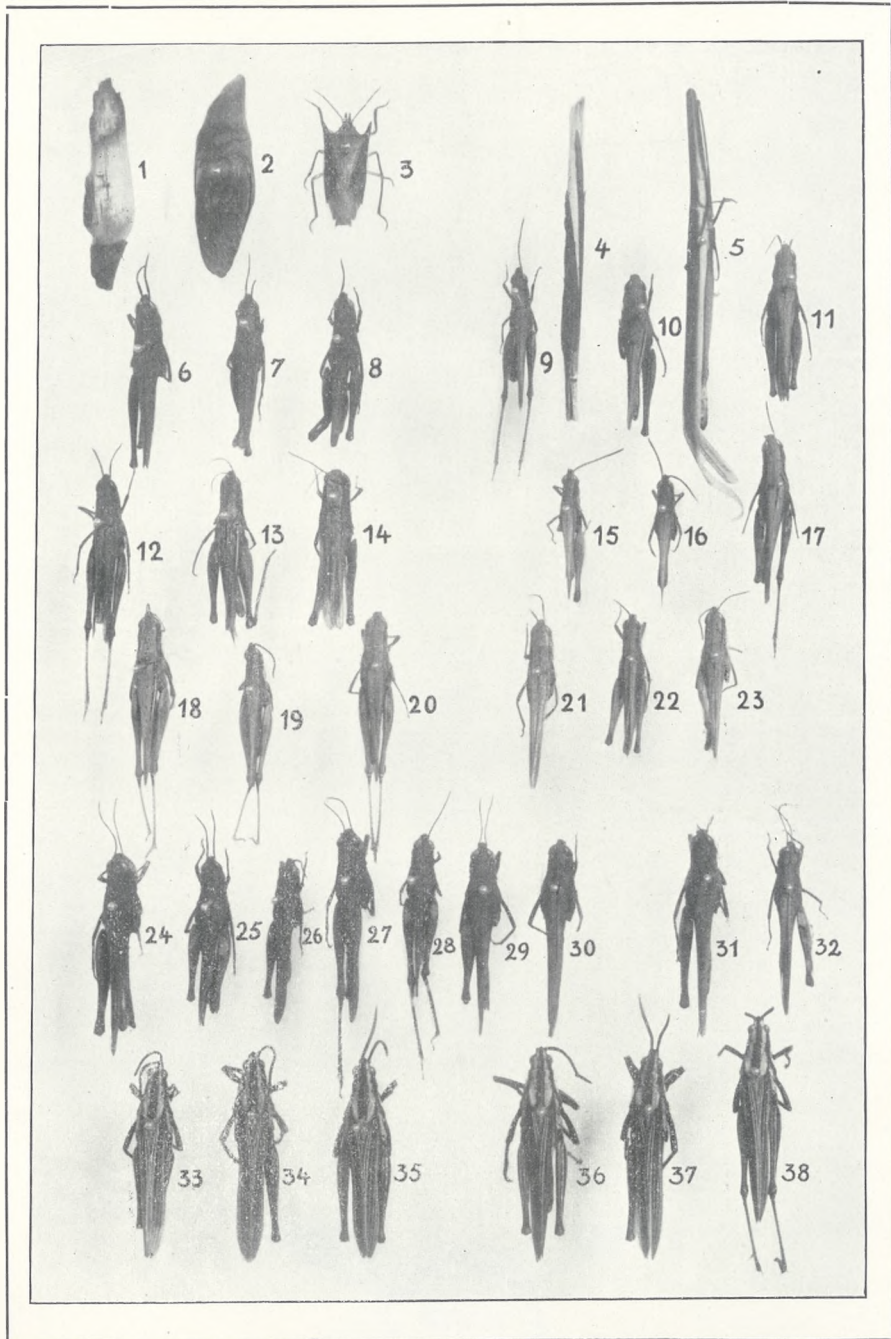
Figs. 36—38. Three examples of the similar uniform series taken on grass burnt about four months: Oct. 21.

The pattern of this species is probably aposematic, warning enemies of distasteful qualities, and the species is apparently entirely unaffected by the conditions, the two series being alike.

<sup>6</sup> The seven specimens (No. 13) doubtfully referred to *P. temporalis* were accidentally chosen to contrast with the two (No. 12) determined as this species by Mr. Uvarov. Reference to p. 444 will shew that the contrast would have been stronger if both series had been selected from No. 12.







*Edward B. Poulton*: Protective resemblance borne by certain African insects to the blackened areas caused by Grass Fires.

The described differences of shade are not quite sufficiently indicated on the plate.







