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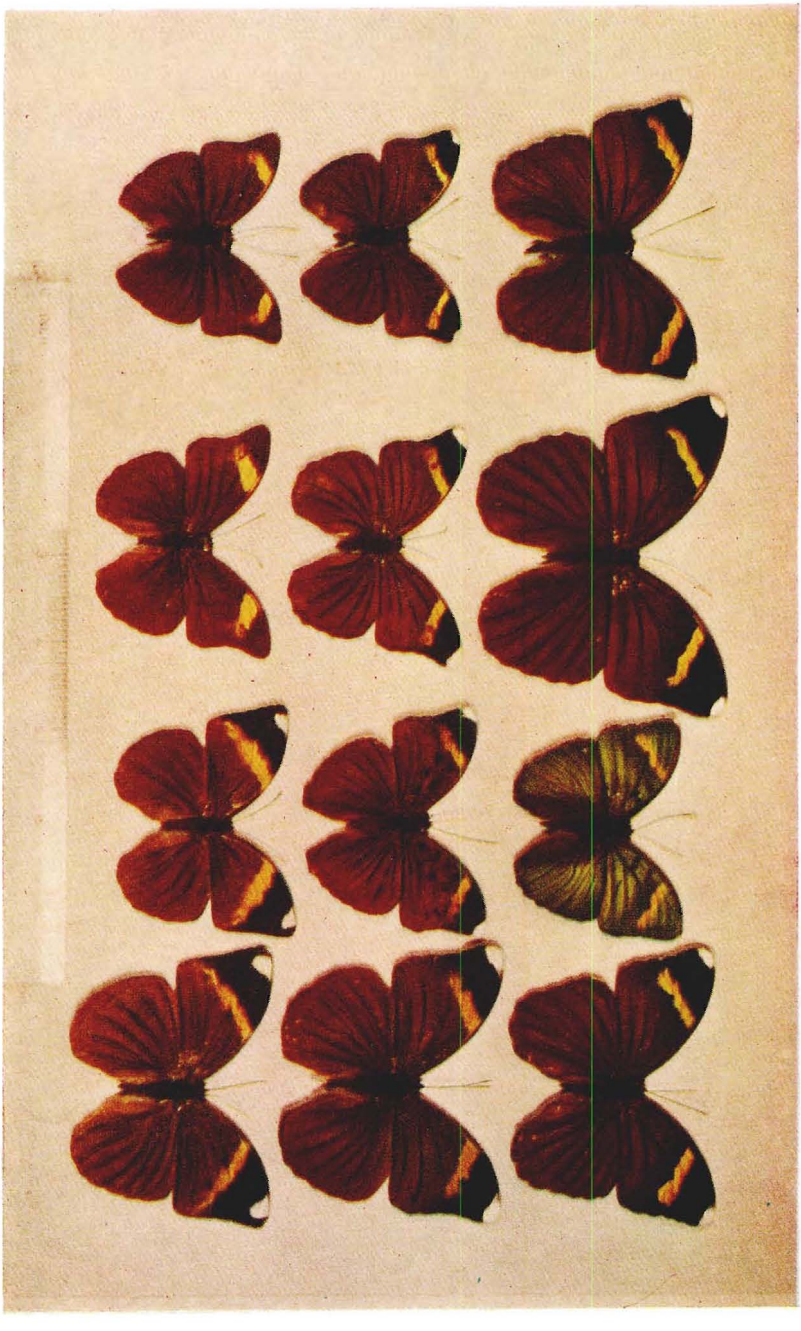

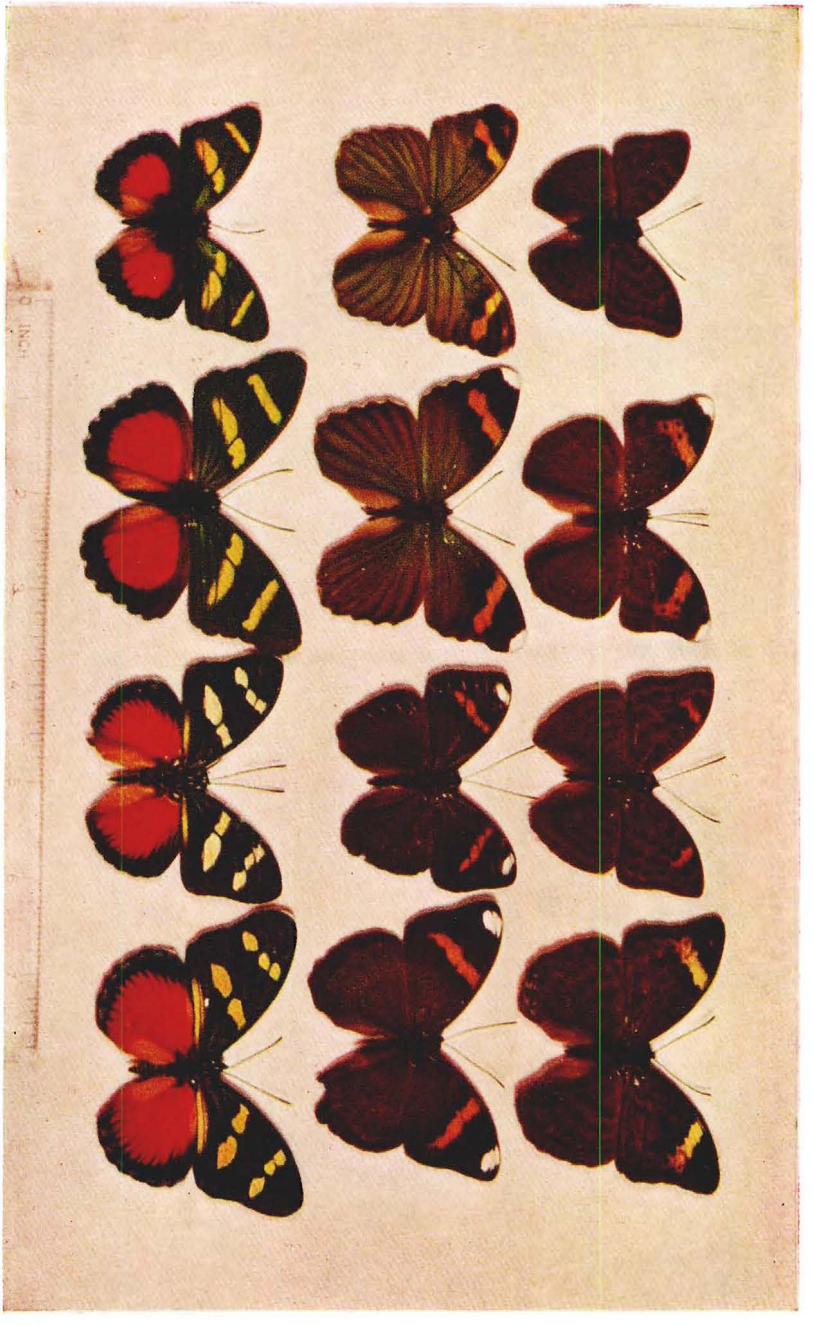

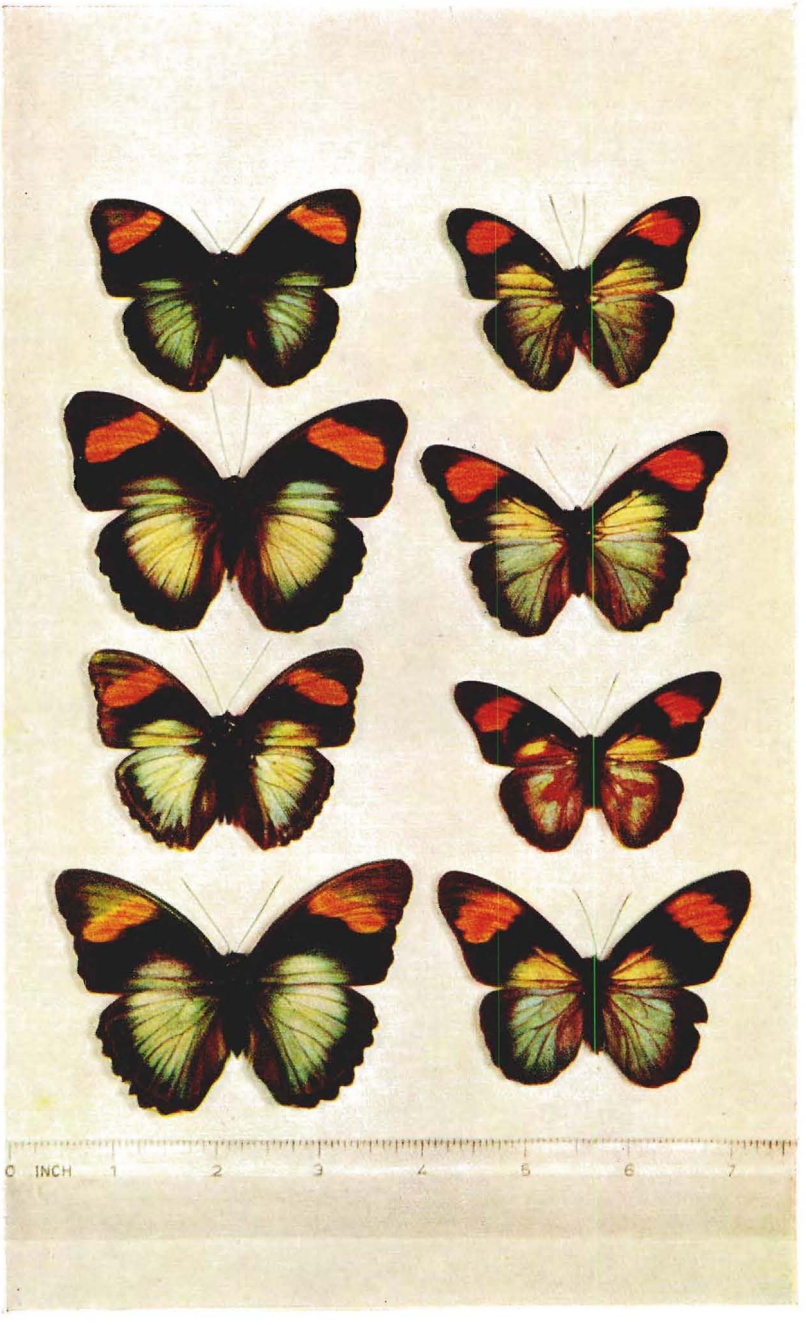
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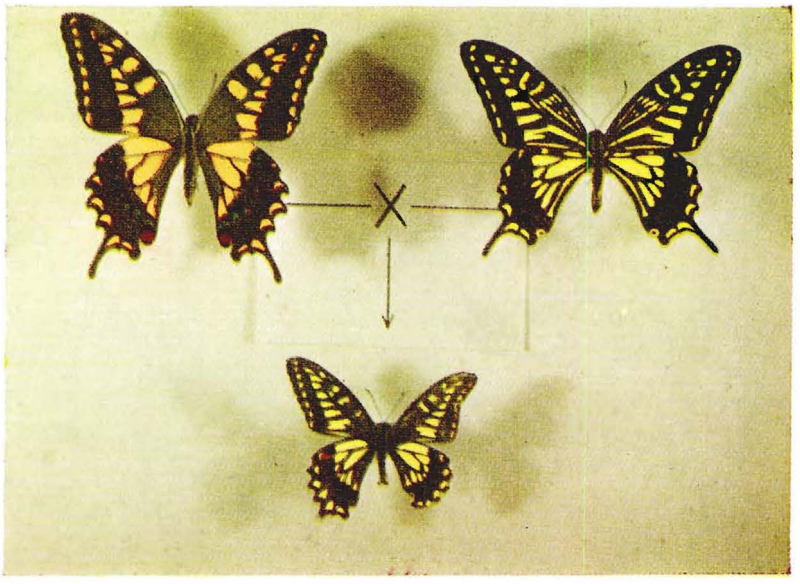

Fig. 1. *P. hippocrates* (left), *P. xuthus* (right), and F_1 hybrid (below).

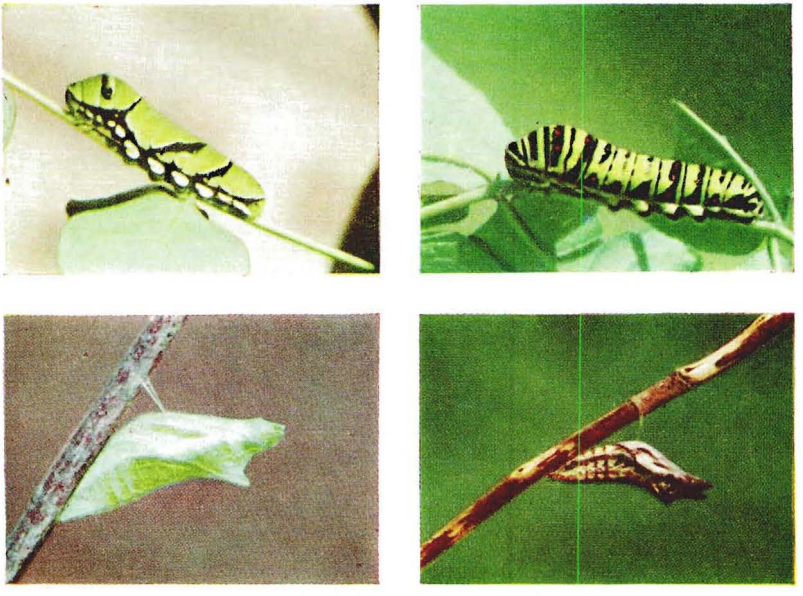

Fig. 2. Left, larva and pupa of *P. xuthus;* right, same of F_1 hybrid (*hippocrates* × *xuthus*).

JOURNAL OF
THE LEPIDOPTERISTS' SOCIETY

Volume 13 1959 Number 3

SOME COMMENTS ON PROTECTIVE RESEMBLANCE AMONGST AFRICAN LEPIDOPTERA (RHOPALOCERA)*

by V. G. L. VAN SOMEREN and T. H. E. JACKSON

INTRODUCTION

The essence of life is the ability to survive, and the chances of survival of a species largely depend on the degree of plasticity or adaptability exhibited by that species in the struggle for existence. Natural Selection, working on small mutations, inherent in the genetics of all forms of life, is the means whereby adaptation is achieved. The struggle for existence has gone on since the dawn of Life and must therefore be of universal application. The object of this paper is to give certain evidence, so far as African Lepidoptera (Rhopalocera) are concerned, in support of this view on Evolution.

CHARLES DARWIN, in his *Origin of Species,* expounded the broad principles governing the formation of species, and the application of these principles to the special case of "Mimicry" and Müllerian Resemblance formed the classical writings of BATES, WALLACE, MÜLLER, TRIMEN, POULTON, and others.

In so far as Africa is concerned, attention was first focussed on the subject by TRIMEN, and later by POULTON and HALE CARPENTER. They were amply assisted in the field by such great naturalists as MARSHALL, SWYNNERTON and CARPENTER himself. It was shown that in Africa "Mimicry and Mullerian Resemblance" centered around two compact groups of distasteful butterflies, the Danaidæ and Acræidæ, the mimics being found chiefly amongst the Nymphalidæ, Papilionidæ and Lycænidæ.

The accumulated knowledge was crystalized and ably illustrated by ELTRINGHAM in his *African Mimetic Butterflies* (1910), and the work has been carried still further by POULTON, CARPENTER and others.

SIMPLE OR PRIMITIVE MIMICRY

To those who have had the opportunity of extensive collecting in Africa, the impression must have been conveyed at some time or other that numerous species appear deceptively alike. This may be noted in the field, or perhaps

* The cost of several of the colored plates with this paper has been financed by the generous support of MARGARET M. CARY, L. B. DOYLE, B. HEINEMAN, S. A. HESSEL, R.R. MCELVARE, and B. STRUCK; the remainder has been borne by the authors. — C. L. R.

not even until the end of the days' collecting when the captures are being examined. Obvious examples of Batesian mimicry and Müllerian Resemblance are noted, but there are others outside these two catagories which obtrude themselves, for example the numerous species of *Neptis* which were taken flying together in the same area, all black and white, all very similarly patterned, some large, some small, not distinguishable on the wing, yet obviously different when closely examined. Some turn out to be common, others rare. Then one may note amongst the captures certain examples which are not *Neptis* nor *Neptidopsis,* but female *Euptera* or even *Pseudothyma.*

Our own experience in the field supplies ample evidence that the theory of Batesian Mimicry and Müllerian Resemblance is sound. We feel however that many simpler and more primitive forms of "protective resemblance" have been overlooked, largely perhaps because it was always considered essential to find a distasteful model around which a group could be centered. We submit that this criterion is not always necessary, and further, that since "Batesian and Mullerian Resemblance" are very highly specialised products of evolution, the more primitive groups would be most unlikely to contain distasteful models. It is necessary therefore, to look for much simpler factors in the "models" which would nevertheless be sufficient to bring the forces of Natural Selection into play. The use of the term "primitive" is relative: here a contrast between groups which have evolved specialised glands and fluids to promote protection, thus highly specialised products, and groups which have not. A species may go on mutating and forming other species, which latter will be "younger" as species than their ancestors; and conversely, another may not mutate, or may not mutate so fast, and yet may be found today in its original form along with species 1a and 1b; thus No. 2 might be considered "more primitive" than 1a or 1b.

The Müllerian groups present the greatest evolutionary advance amongst Rhopalocera; they possess specialised glands whose secretions are relatively nauseating to would-be predators and thus enjoy a high degree of immunity to attack. Due to this, they have evolved certain pronounced and unusual habits such as slow sailing flight, they select exposed positions for resting, and are almost devoid of "fear" responses.

We suggest that "Protective Resemblance" exists among relatively *edible* Rhopalocera and can be divided into three natural groups each involving factors other than distastefulness, as follows:

A. *Large size, great strength, and toughness of integument* such as we find amongst the Charaxidinæ.

B. *Difficulty of capture, i.e.* quickness of flight together with great power of vision and wariness; a form of low flight which is obliterative, the colours of the upperside (browns, blues, and greens chiefly) being eminently suited to the environment and blending with high-lights and shadows; a flight close to the ground, in and out of the undergrowth so that the colours appear intermittently.

Examples: Nymphalinæ, especially *Euphædra, Euryphene, Euryphura,* and *Diestogyna.* (The late Prof. HALE CARPENTER suggested the term "dysleptic", *i.e.* difficult to capture, for this group.)

C. *Safety in numbers.* A species will gain by resemblance to another species, if attacked, by the simple law of average. There is no limit to the number of species that may be so associated. This is the principle involved in Müllerian Resemblance amongst associated distasteful species, and there appears no reason why it should not apply to relatively edible species as well. Among a group such as this, it would assure that no one edible species would be preyed upon to the exclusion of the others. Thus ELTRINGHAM (1910: p.19) quoting from MELDOLA'S translation of MÜLLER'S original paper, wrote: "If both species are equally common then both will derive the same benefit from their resemblance — each will save half the number of victims which it has to furnish to the inexperience of its foes. But if one species is commoner than the other, then the benefit is unequally divided, and the proportional advantage for each of the two species which arises from their resemblance is *as the square* of their relative numbers. . . . Let us suppose that in a given region . . . . 1200 butterflies of a distasteful species have to be destroyed . . . . and that in this region there exist 2,000 individuals of one (A) and 10,000 of another (B) distasteful species. If they are quite different, each species will lose 1,200 individuals; but if they are deceptively alike, then this loss will be divided among them in proportion to their numbers, the first (A) will lose 200, and the second (B) 1,000. The former (A) accordingly gains 1,000 (or 50 percent.) of the total loss, and the latter (B) only 200 (or 2 percent.) of this number. Thus while the relative number of the two species is in the ratio of 1 : 5, the advantage derived by those possessing the resemblance is 25 : 1." These remarks of course referred to two distasteful species, but they apply equally well to non-distasteful. There is thus an "arithmetic" basis to the degree of advantage accruing, and it is this *"arithmetic"* aspect, so well exemplified in what we term *Simple or Primitive Mimicry* among edible groups to which we wish to call attention, and emphasise. The principle involved in these groups is precisely that quoted by ELTRINGHAM. Although we have cited other attributes which may possibly assist in the protection of the species, this "arithmetic" aspect applies in all groups. We submit the following grouping and examples.

PROPOSED GROUPING IN MORE DETAIL

Group A. Nymphalidæ: Charaxidinæ.

The similarity of colouration and pattern amongst many *Charaxes* was drawn attention to by POULTON (1926). He cited various examples and these we repeat here with additions and corrections to the nomenclature. The models are common and always larger and are characterised by tough integument, considerable fighting power, strong flight and comparative wariness.

The mimics are always smaller and weaker, and often rare. This is, in fact, a form of Müllerian mimicry in that it involves a deterrant in the models, but of a kind differing from that implied in the usual concept of Müllerian resemblance based on *distastefulness*. The resemblance in Group A is one of colour and pattern alone; all are *edible*.

MODEL	MIMIC
Charaxes tiridates Cramer ♂	*C. numenes* Hew. ♂ *C. bipunctatus* Roths. ♂ *C. mixtus* Roths. ♂ & ♀ *C. etheocles* Cramer ♀ f. "alladinis"
C. tiridates ♀ (See Plate 1)	*C. numenes* ♀ *C. bipunctatus* ♀ *C. cedreatis* Hew. ♀
C. bohemanni Felder ♂ (See Plate 1)	*C. viola phæus* Hew. f. ♀ "phæus" *C. manica* Trimen, f. ♀ "pseudophæus"
C. bohemanni ♀ (See Plate 1)	*C. manica* Trimen, f. ♀ "manica" *C. fulgurata* Aur. f. ♀ "fulgens" *C. fulgurata* f. ♀ "lunigera"
C. brutus Cramer	*C. hildebrandtii* Dewitz ♂ & ♀ *C. baumanni* Rog. ♂ & ♀ *C. opinatus* Heron ♀ *C. aubyni* Poulton f. ♀ "aubyni"
C. ameliæ Doumet ♀	*C. etheocles* Cramer f. "etheocles" ♀ *C. etheocles* f. "catachrous" ♀ *C. etesipe* Godart f. ♀ "etesipe"
C. castor Cramer	*C. etesipe* Godart f. ♀ "castoroides"
C. protoclea Feisth. ♂	*C. anticlea* Drury ♂
C. pelias saturnus Butler	*C. achæmenes* Felder f. ♀ "achæmenes" *C. viola kirki* Butler f. ♀ "rogersi"
C. cithæron Felder	*C. violetta* Smith ♂ & ♀ *C. ethalion* Bois. f. ♀ "rosæ"
C. ansorgei Roths.	*C. etheocles evansi* van Som. ♀

Many other examples could be quoted, but the above are outstanding amongst this group.

PLATE 1.* Group A. Left row (all from Uganda), top to bottom: ***Charaxes tiridates*** ♀ [C]; ***C. numenes*** ♀ [C]; ***C. bipunctatus*** ♀ [MR]; ***C. cedreatis*** ♀ [MR]. Right row (all from South Africa), top to bottom: ***C. bohemanni*** ♂ [C]; ***C. bohemanni*** ♀ [C]; ***C. viola phæus*** f. ♀ "phæus" [MR]; ***C. manica*** f. ♀ "manica" [MR].

* In all plate captions, C=common, M=moderately, R=rare.

Group B. Nymphalinæ.

The genera, *Euphædra, Euryphene, Euryphura,* and *Diestogyna* possess to a marked degree the characteristics already mentioned for this group. They are denizens of the great African forest regions, which, it is generally agreed, at one time covered most of the continent. They must therefore be a very ancient group and should show, to great perfection, "Protective Resemblance." There is evidence that the age of the Great Primary Forests in Africa is very far removed in time from the present; thus it is fair to assume that the forest faunua is more primitive than that of the savannah and secondary forests. It was in the latter that the high degree of specialisation first evolved (*i.e.* the development of glands secreting acrid and obnoxious substances, as in Acræinæ and Danainæ), in response to the more open and exacting environment. Nevertheless, one cannot assume that the more ancient forest fauna did not also evolve its own forms of protective resemblance, and it is, in part, the object of this paper to draw attention to this fact.

A study of the Nymphalinæ both in cabinet and in the field amply demonstrates that this is the case; the resemblances amongst the whole group are so bewilderingly alike, that a minute examination is often required for separation of the species, and in some cases, particularly *Euphædra,* classification is still far from satisfactory.

The group feeds in the adult stage exclusively on rotting fruits on the ground, with wings closed after a deliberate perceptable *full exposure* of the upper surface. The underside is cryptic. It is the upperside or exposed surface which has been, and still is being modified by Natural Selection. We are convinced that this is no chance resemblance, and the numbers of entirely different models and groups show that it cannot be due to a common environment, parallel development, or consanguinity; several genera may be involved. In some cases both sexes are affected, in others only one sex, and this applies to both models and mimics. The greater the uniformity of colour, the greater the chance of escape of the weaker less numerous species in the association which conform to this colour and pattern, for it must be remembered that the important predators hunt by sight, and colour is therefore all-important. A glance at the examples cited, where are often involved one sex only, species of different genera, and far removed in time, completely rules out any suggestion of consanguinity.

The underside patterns retain the ancient characters diagnostic of the species; within minor limits of variation these are extraordinarily constant. This point cannot be overstressed.

The models are sometimes larger and are always common and dominant species of a given area; the mimics are weaker and often rare.

From amongst several large groups which could be cited, we select to illustrate our point the following examples:

MODEL	MIMIC
Euphædra spatiosa Mab. ♂ & ♀ (See Plates 2 & 3)	*Euphædra medon innotata* Holl. ♀
	Euphædra herberti Sharpe ♀
	Euryphene comus Ward ♂ & ♀
	Euryphene phranza moreelsi Aur. ♀
	Euryphene flaminia Stdg. ♂ & ♀
	Euryphene maximiana Stdg. ♂ & ♀
	Euryphene nivaria Ward ♂ & ♀
	Euryphene rubrocostata Aur.
	Euryphene wilwerthi Aur
	Harmilla hawkeri Joicey & Talbot ♂ & ♀
Euphædra zaddachi Hew.[1] (See Plate 3)	*Euphædra eusemoides imitans* Holl.
Euphædra sarita inanoides Sharpe ♂ & ♀	*Euphædra eberti* Aur. ♂ & ♀
	Euphædra preussi Stdg. ♂ & ♀
	Euphædra xypete cyanea Holl. ♂ & ♀
	Euphædra xypete cærulescens Smith ♂ & ♀
	Euphædra karschi Bartel ♂ & ♀
	Euryphene aurivilii Niep. ♂ & ♀
	Euryphene phantasia Hew. ♀ white bar
	Euryphene severini Aur. ♀
	Euryphene chlæropis B. Baker ♀
	Euryphene leptotypa B. Baker ♀
	Euryphene luteola B. Baker ♀
Euphædra ceres Fab. (See Plate 4)	*Euphædra gausape* Butler ♂ & ♀
Euphædra themis aureola Kirby (See Plates 4, 5)[2]	*Euphædra cyparissa aurata* Carp. ♂ & ♀
	Euryphene sophus sophus Fab.
	Euryphene congolensis Capron.
	Euryphene phranza phranza Hew.
	Euryphene lætitia Plötz
	Euryphene cutteri Hew.
	Euryphene sp. nov. ?

[1]The diurnal agaristid moth *Xanthospilopteryx longipennis* Wlk. is thought to be the primary model, but the moth is sporadic in appearance, and field experience shows that *E. zaddachi,* which is very common, is the model for *E. eusemoides imitans.*

[2]Note that the uppersides are amazingly alike, but the undersides of all are very different and fully diagnostic of the species.

PLATE 2. Group B. All from eastern Belgian Congo. Left two rows: top, *Euphædra spatiosa* [C]; middle, *E. flaminia* [MC]; bottom, *E. nivaria* [R]. Right two rows: top, *E. medon innotata* (♂ non-mimetic) [C]; middle, *E. maximiana* [MR]; bottom, *E. comus* [MR]. For each species on plates 2, 3, 5, ♂ is at left, ♀ at right.

PLATE 3. Group B. All from eastern Belgian Congo. Left two rows: top, *Euryphene phranza moreelsi* [R]; *E. rubrocostata* [R]; *Euphædra zaddachi* [C]. Right two rows: *Euryphene wilwerthi* [MR]; *Harmilla hawkeri* [R]; *Euphædra eusemoides imitans* [R].

PLATE 4. Group B. All from Nigeria. Left row: top, *Euphædra ceres* ♂ [C]; 2nd, same, ♀; 3rd, *E. themis aureola* ♂ [C]; bottom, same, ♀. Right row: top, *E. gausape* ♂ [MR]; 2nd, same, ♀; 3rd, *E. cyparissa aurata* ♂ [MR]; bottom, same, ♀.

PLATE 5. Group B. All from Nigeria. Left two rows: top, *Euryphene sophus sophus* (♂ non-mimetic)) [C]; middle, *E. lætitia* (♂ non-mimetic) [MR]; bottom, *E. cutteri* [MC]. Right two rows: top, *E. phranza phranza* (♂ non-mimetic) [MC]; middle, *E. congolensis* (♂ non-mimetic); bottom, *E. sp. nov.*? [R].

MODEL	MIMIC
Euryphene absolon Fab. ♀ (See Plates 7, 9, 10)	*Euryphene subtextyris* Strand ♀
	Euryphene abesa Hew ♀
	Euryphene zonara Butler ♀
	Euryphene maxdinga Felder ♀
	Euryphene cottoni B. Baker ♀
	Euryphene oxione squalida Talbot ♀
	Euryphene ikelemba Aur. ♀
	Diestogyna ribensis Ward ♀
	Diestogyna camarensis Ward ♀
	Diestogyna goniogramma Karsch ♀
	Diestogyna luteostriata B. Baker ♀
	Diestogyna saphirina Karsch ♀
	Diestogyna ituriensis Jackson & Haw. ♀
	Diestogyna intermixta Aur. ♀
	Diestogyna gambiæ Feist. ♀
	Cynandra opis Drury ♀

It is usually assumed that the primary models for this group are the species of *Catuna,* said to be distasteful, but we doubt if they can be considered "inedible" in the same way as Danainæ and Acræinæ. In the absence of evidence to the contrary, it is assumed that Nymphalidæ (excluding Danainæ and Acræinæ auct.) and all other families of Rhopalocera (excluding the pierid genus *Mylothris*) are edible in some degree, as is born out by our experience in the field. We are certain that there is much "secondary" mimicry centered round the very common female of *Euryphene absolon,* assisted by *Catuna.*

There is some evidence that there are several species amongst the *Euphædra eleus* group closely mimicking each other, but they require further investigation. Sufficient evidence, however, has been given in support of our contention that the Nymphalinæ have developed an amazing degree of perfection in "protective resemblance" built up on an "arithmetic" basis.

Group C. Pieridæ, Lycænidæ, Hesperiidæ.

Pieridæ: The common red-tipped group of *Colotis,* the black and white *Anaphæis* and *Belenois,* and the various species of *Eurema* are good examples of "Ochlosis", and it is unnecessary in a brief review such as this to give long lists of species which come within this catagory. The value of this form of resemblance was amply demonstrated during a visit to the Tana River near the Mbere country where the above groups were being preyed upon by numbers of Robber Flies (Asilidæ, Diptera). We noted that species of *Colotis* seemed to be equally common and no one species suffered to the exclusion of another. However, in one particular area which was very restricted, we found the uncommon species *Colotis pallene rogersi* Dixey. It was closely associated with its food plant, also a species of very restricted distribution; but in this same area there were three other very common *Colotis,* notably the widespread *C. evenina* Wall. which often has dimorphic females, but at this time all were of the dry-season form with red tips thus presenting

a perfect model for the smaller and rarer *C. pallene rogersi.* We wanted this species, but for every one secured we netted a dozen *C. evenina.* Examples such as this, together with certain lycænids listed hereafter, are probably based on the numerical principle involved in Müllerian Resemblance, as quoted previously, and are *not* true "Ochlosis" since they consist of one very common model and a scarce mimic. We figure some of the *Colotis* involved, on Plate 6. These suffice to indicate the similarity: *Colotis daira thruppi* Butler, *C. antevippe* Bois., *C. evenina casta* Gerst., *C. pallene rogersi* Dixey.

Lycænidæ: There are numerous examples of this type of mimicry amongst the Lycænidæ, too numerous to list in detail in this brief paper, and it will suffice to mention just a few. The sexes are often dissimilar, and moreover one or other is sometimes non-mimetic.

Examples: Lipteninæ.

MODEL	MIMIC
Liptena ideoides Dewitz ♂ & ♀	***Eresina rougeouti*** Stemp. ♂ & ♀
	Eresina conradti Stemp. ♂ & ♀
Liptena modesta Kirby ♀	*Liptena rubromaculata* Strand ♀
Teriomima minima Trimen	*Eresinopsis bichroma* Strand

Other examples amongst the *Liptena* centered around *L. opaca* Kirby could be cited. Most of the *Ornipholidotos* form a mimetic group centered around the very common *O. kirbyi* Aur.

In the large genus *Epitola* in which the sexes are dimorphic, many fly together and very closely resemble each other.

PLATE 6. Group C. All Lipteninæ (left) from Katera, Masaka, Uganda; all Pieridæ (middle, right) from Emberre, Tana River, Kenya. Left row: top, *Liptena ideoides* ♂ [C]; 2nd, same, ♀ ; 3rd, *Eresina rougeouti* ♂ [R]; 4th, same, ♀ ; 5th, *E. conradti* ♂ [R]; bottom, same, ♀. Middle row: top, *Colotis daira thruppi* ♂ [MR]; 2nd, same, ♀ ; 3rd, *C. evenina casta* ♂ [MC]; bottom, same, ♀. Right row: top, *C. antevippe* ♂ [C]; 2nd, same, ♀ ; 3rd, *C. pallene rogersi* ♂ [R]; bottom, same, ♀.

PLATE 7. Group B. All from eastern Belgian Congo. Males non-mimetic. Top two rows (♂ above, ♀ below): left, *Euryphene absolon* [C]; center, *E. mandinga* [MC]; right, *E. subtentyris* [MC]. Middle: left above, *E. abesa* ♂ [MC]; left below, same, ♀ ; right (large), *E. ikelemba* ♀ [R]. Bottom two rows (♂ above, ♀ below): left, *E. zonara* [MC]; center, *E. oxione squalida* [MC]; *E. cottoni* [R].

Lycæninæ. There are several groups of associated Lycæninæ which are to be found flying around their food plants (here various species of *Loranthus*) which are remarkably alike. The majority are sexually dimorphic. We cite an outstanding example which we noted in the west Madi, West Nile district of Uganda.

MODEL	MIMIC
Argiolaus ismenias Klug ♂ & ♀ (See Plate 8)	*Argiolaus crawshayi niloticus* Stemp. & Bennett, ♂ non-mimetic
	Argiolaus menas Drury, ♂ non-mimetic
	Argiolaus vansomereni Stemp. & Bennett, ♂ non-mimetic
	Dapidodigma hymen Fab.
	Stugeta marmorea Butler
	Epamera scintillans Aur., ♂ non-mimetic
	Epamera aphnæoides nasissii Riley, ♂ non-mimetic
	Epamera iasis albomaculata Sharpe, ♂ non-mimetic

Among other groups we note:

Anthene opalinus Stemp. ♂ & ♀	*Anthene otacilia benadirensis* Stemp. ♂ & ♀
Anthene contrastata Ungemach	*Anthene talboti* Stemp.
Virachola livia Klug	*Virachola dohertyi* B. Baker *Virachola suk* Stemp. ♂
Anthene amarah Guérin ♀	*Virachola suk* ♀
Chloroselas pseudozeritis Trimen	*Desmolycæna rogersi* B. Baker

All the above are sexually dimorphic and each sex of the mimic closely resembles the corresponding sex of the model, above and below. Model and mimic fly together around *Acacia* trees.

Hesperiidæ. Examples of mimetic associations among the African Hesperiids are numerous but still require detailed study. An outstanding association is to be found among the genus *Spialia* where all the species are white-

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PLATE 8. Group C. All from Metu, West Madi, Uganda. Left row: top, *Iolaus ismenias* ♂ [C]; 2nd, same, ♀; 3rd, *I. crawshayi niloticus* ♂ [C] (non-mimetic); 4th, same, ♀; 5th, *I. menas* ♂ [MC] (non-mimetic); bottom, same, ♀. Center row: top, *I. vansomereni* ♂ [R] (non-mimetic); 2nd, same, ♀; 3rd, *I. hymen* ♂ [R in this locality]; 4th, same, ♀; bottom, *I. marmorea* ♀ [MR]. Right row: top, *I. scintillans* ♂ [R] (non-mimetic); 2nd, same, ♀; 3rd, *I. aphnæoides nasissii* ♂ [MC] (non-mimetic); 4th, same, ♀; 5th, *I. iasis albomaculata* ♂ [MR] (non-mimetic); bottom, same, ♀.

spotted on a dark ground; many fly together, some very common, others very rare. Thus in one area in northern Uganda when we were hunting for *Spialia wrefordi* Evans, we netted six *S. colotes transvaaliæ* Trimen and about the same number of *diomus* Hopffer for every one *wrefordi*.

Apart from group associations there are instances where two species of different genera resemble each other closely and fly together:

MODEL	MIMIC
Cæliades libeon Druce	*Pteroteinon iricolor* Holl.
Cæliades forestan Cramer	*Mopala orma* Plötz
Cænides dacela Hew.	*Pteroteinon pruna* Evans
Kedestes callicles Hew.	*Kedestes rogersi* Druce

The foregoing evidence is, we submit, sufficient to support the suggestion that there does exist a simple form of mimetic association which is "Protective Resemblance", and there is not the slightest doubt as to the value of this association to the weaker and less common species. The results achieved are in every way parallel to those accruing from Batesian Mimicry and Müllerian Resemblance. The groups we have drawn attention to differ only in regard to the fact that distastefulness is not a *sine qua non* either in the models or associated members. We submit that the evidence here given, amplifies, and does not run contra to the great Theory of Mimicry.

It has been suggested that Müllerian Resemblance is in a class by itself and that it does not imply deceit; we do not subscribe to this view. A predator would obviously be equally deceived between *Danaus chrysippus* L. and *Acræa encedon* L., or *Acræa pharsalus* Ward and *A. cepheus* L., as it would between *Acræa karschi* Aur. and *Mimacræa krausei* Dewitz.

All categories of Protective Resemblance result in the same thing, *i.e.* the increase in the chances of survival of the species concerned, and differ only in the factors by which they are governed to achieve this end. The Müllerian groups are merely the most highly advanced, but even here, as we have shown, the "arithmetic" aspect, so ably demonstrated by MÜLLER himself, plays an important part.

The theory embodied in this paper is not a new one, since A. R. WALLACE (1889: p. 245), referring to F. MÜLLER'S account of the female of *Leptalis melite* (L.) imitating one of the common Brazilian Pieridæ, wrote: "This is evidently not a case of true mimicry, since the species imitated is not protected; but it may be that the less abundant *Leptalis* is able to mingle with the female Pieridæ and thus obtain a partial immunity from attack." Thus the phenomenon to which we draw attention is widespread, and not limited to Africa!

PLATE 9. Group B. All from Nigeria. Males non-mimetic. Left row: top, *Cynandra opis* ♂ [C]; 2nd, same, ♀; 3rd, *Diestogyna saphirina* ♂; 4th, same, ♀; 5th, *D. gambiæ* ♂ [C]; bottom, same, ♀. Center row: top, *D. ribensis* ♂ [C]; 2nd, same, ♀; 3rd, *D. goniogramma* ♂ [MR]; bottom, same, ♀. Right row: top, *D. intermixta* ♂ [R]; 2nd, same, ♀; 3rd, *D. camarensis* ♂ [R]; 4th, same, ♀; 5th, *D. ituriensis* ♂ [R]; bottom, same, ♀.

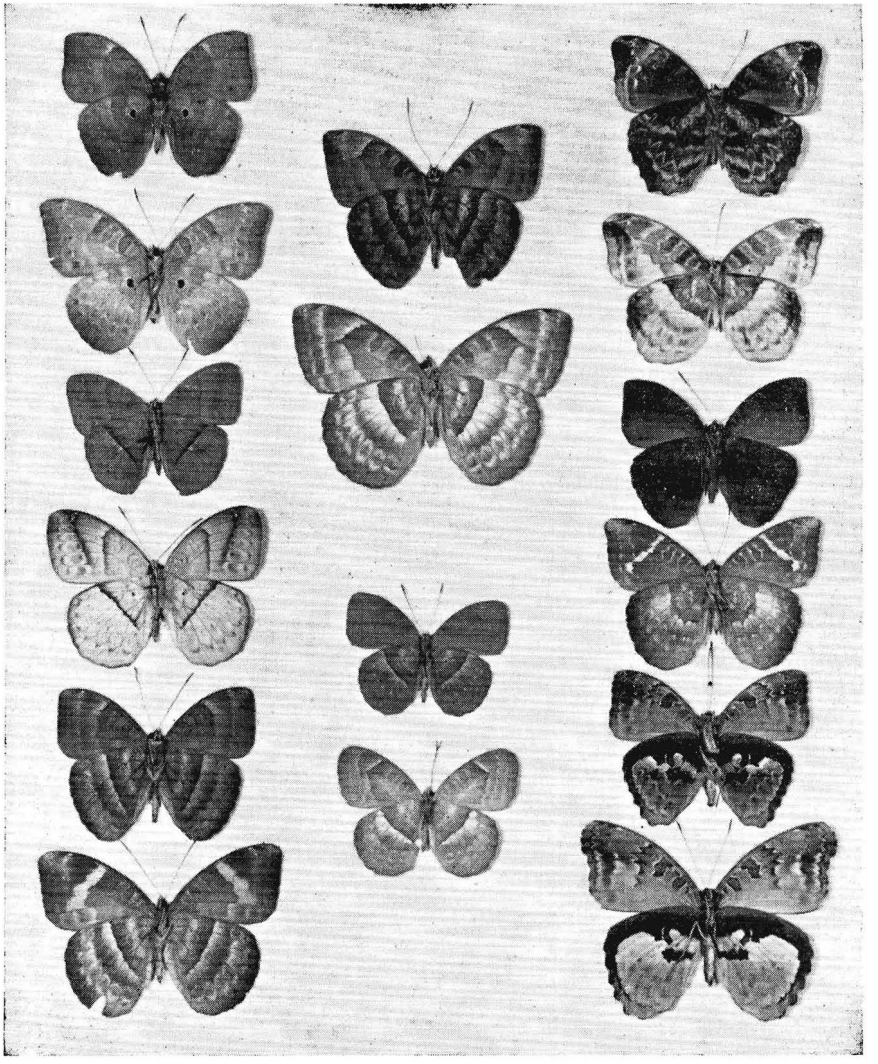

PLATE 10. Undersides of same specimens as in Plate 9.

TERMINOLOGY OF MIMICRY

We submit that there is a case for the overhaul of the terminology of Mimicry, from Crypsis to the highly specialised Müllerian groups, and that new terms are desirable for the categories we have cited in this paper.

We suggest the following broad classification of Mimicry:

1. SIMPLE or PRIMITIVE (Apatetic colouration). ARITHMETIC

a) No distasteful model; all edible. Where several species centre around abundant powerful species	CHARAXINÆ: as cited by POULTON and here amplified.
b) No distasteful model; all edible. Where several species centre around an abundant successful species whose characteristics are: elusiveness, quickness of flight low to the ground; obliterative colouration; acute vision and wariness. "Dysleptic", (difficult of capture) was suggested by CARPENTER.	NYMPHALINÆ: *Euphædra, Euryphene, Euryphura, and Diestogyna*, as cited in the text.
c) No distasteful model; all edible. Where several similarly coloured and patterned species fly together. Safety in numbers; the mortality rate is shared and in ratio to numbers. The term "OCHLOSIS" was suggested by CARPENTER. We propose ARITHMETIC as a better term applicable to all three groups.	PIERIDÆ: as cited. LYCÆNIDÆ: Lipteninæ & Lycæninæ as cited.

2. BATESIAN MIMICRY (Aposematic and Pseudaposematic).

A distasteful model present, around which edible species resembling it are associated; i.e., warning model and deceitful mimics.	ACRÆIDÆ: *Bematistes, Acræa.* DANAIDÆ: with which are associated Nymphalidæ, Papilionidæ & Lycænidæ.

3. MÜLLERIAN RESEMBLANCE (Aposematic colouration; i.e., warning colours).

Several distasteful species conforming to a common colouration and pattern; degree of deterrant character varying in participating members.	DANAIDÆ, ACRÆIDÆ (African) as so often cited in literature.

References

Eltringham, H., 1910. *African mimetic butterflies.* Oxford Press. 136 pp., 10 pls.

Poulton, E. B., 1926. Mimicry in African butterflies of the genus *Charaxes,* with a classification of the species. *Verh. III. int. Ent. Kongr.* 2: 518-575.

Wallace, A. R., 1889. *Darwinism.* Macmillan & Co., London. 494 pp., 37 figs.

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