

SUGGESTIONS AS TO THE MEANING OF
THE SHAPES AND COLOURS
OF THE MEMBRACIDÆ

IN THE
STRUGGLE FOR EXISTENCE

BY

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PRESIDENT OF THE ENTOMOLOGICAL SOCIETY OF LONDON

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IN studying the meaning and use of insect colour and form it is deeply interesting to compare broadly the two great divisions of the RHYNCHOTA. The HETEROPTERA (HEMIPTERA) are obviously, as a whole, a specially protected group, commonly defended by taste or smell from large numbers of insect-eating animals. Warning or aposematic colours and patterns abound among them, while their movements are such as to promote the conspicuous effect of strongly contrasted tints. Groups of species in the same locality often possess similar aposematic colours, thus enabling their young and inexperienced enemies to learn and remember the appearance of unpalatable forms, with a comparatively small waste of life. Such resemblances are often spoken of as Müllerian Mimicry, after the naturalist who first suggested the benefits which arise from facilitating the education of foes. They may also be called by the more descriptive title "Common Warning," or "Synaposematic" colours. For it is clear that in such cases we have to do with the useful possession of warning colours in common rather than with the benefits conferred by "Protective Mimicry" (Pseudaposematic colours) as defined by H. W. Bates. By these latter resemblances a rare, much persecuted, palatable form is believed to be mistaken by enemies for an abundant species, well known and avoided because of some special mode of defence. Good examples of S. African HETEROPTERA with common warning colours have recently been described and figured by Mr. Guy A. K. Marshall (*Trans. Ent. Soc. Lond.*, 1902, p. 537).

When we find the HETEROPTERA resembling specially protected insects of other Orders, such as the conspicuous distasteful groups of Coleoptera: the *Lycidæ* (l.c. p. 515), the *Cantharidæ* (p. 518), the *Coccinellidæ* (p. 520), or the aggressive

HYMENOPTERA (p. 535), the question at once arises as to whether the likeness is to be explained by the theory of H. W. Bates or by that of Fritz Müller. The evidence for the existence of a widespread distastefulness among the HETEROPTERA strongly suggests the latter interpretation rather than the former. It is hardly necessary to remark that there are numerous exceptions to these broad statements. Beautiful examples of cryptic defence are well known in the HETEROPTERA even of this country. Nevertheless the group, as a whole, is characterised by the abundance and conspicuousness of aposematic and synaposematic combinations of colours, the resemblances to insects outside the group falling probably into this latter category.

The RHYNCHOTA HOMOPTERA are sharply contrasted with the HETEROPTERA, cryptic colours and patterns being relatively common among them, although some of the divisions are very conspicuous and probably aposematic. When resemblances to other insects occur they are probably to be explained as Batesian (Pseudaposematic = Protective) Mimicry, when the most nearly allied non-mimetic species of HOMOPTERA possess a cryptic defence (Protective Resemblance), as Müllerian (Synaposematic = Common Warning Colours) when the allied species are conspicuous with aposematic or warning colours.

Allusion must be made to the special and curious defence by a waxy secretion which is common in the HOMOPTERA. The method may be compared to the defensive silken walls of the cocoon in other insects, while the long trailing filaments of wax borne by certain species of HOMOPTERA may play the same part as the "tails" on the hind wings of many LEPIDOPTERA, or the "tussocks" of hair on some of their larvæ—all these probably acting as directive structures which divert the attention of an enemy from the vital parts.

The deeply interesting section of the HOMOPTERA which forms the subject of the present memoir has an important bearing upon the bionomics of insect colouring, affording as it seems to the present writer, one of the most convincing of all the arguments which have been adduced in support of an interpretation based upon the theory of natural selection.

The *Membracidæ*, as a whole, appear to depend chiefly upon Protective Resemblance, concealment being effected by likeness to various vegetable structures. Examples of resemblance to other insects—ants, beetles, &c.—are found in many species, but the interpretation of these as Batesian or Müllerian is better considered after the examples themselves have been dealt with.

Resemblances to other insects and to the vegetable environment are, of course, extremely common throughout the Insecta, but nowhere (except in a few ORTHOPTERA) are they produced in the same manner as in the *Membracidæ*. The deceptive disguise of other insects is manifest in various parts of the body, and often in many parts

together : in the *Membracidæ* the disguise is chiefly borne and often solely borne by the pronotum alone. The marked resemblance to ants in the genus *Heteronotus*, the strange and remarkable shapes which we should probably recognise as cryptic if we saw the living insects in their natural environment—these are borne by a mask which is a development from a relatively small part of the organism. The Membracid, as a whole, bears not the slightest resemblance to ant or thorn or bark, but it is covered by a shield which does bear a striking resemblance in some species to the first, in others to the second, in others again to the third, of these objects.

Those who oppose the interpretation based on natural selection are therefore faced by the question—how, except by selection, can it be conceived that the variations of shape in the pronotal shield of an insect can have been guided into the superficial resemblance to an ant, while variations in the whole body-form of another have assumed the same appearance, while in a third the likeness is indicated by colour alone, resulting in the invisibility of those parts which would interfere with the resemblance? The attainment of the same end by entirely different means affords strong support to the opinion that the end is advantageous. On any other hypothesis as yet put forward it is a meaningless coincidence that the model suggested in each of these three different ways, is the same specially aggressive and well-known insect. This argument was first suggested by the present writer at the Toronto meeting of the British Association in 1897 (Report of the Meeting, page 692) and was further developed with the aid of illustrations in the *Journal of the Linnean Society* (Zoology, Vol. XXVI., pp. 588–595).

In the following pages I have employed the word “mimicry” to indicate resemblances to other species of animals. Likeness to plant structures, &c., for the purpose of concealment I have invariably called “cryptic” or “protective resemblance.” Among the *Membracidæ* such concealment is always “procryptic,” for the purpose of defence; although anticryptic or aggressive resemblances to plants are well known in insects, especially in the flower- and leaf-like mantides (see page 153).

In discussing the effect of hereditary bias towards particular colouring (see page 200) I was considering only the cases of insects in which each individual possesses a power of special adjustment to two or more of its possible environments. For example the larvæ of the moth *Amphidasis betularia* have the power of becoming black on a plant with black twigs, green when the twigs are green, white when they are glaucous, &c. (*Trans. Ent. Soc. Lond.*, 1892, pp. 326–360). This individual adaptability and freedom from bias is clearly advantageous. If, for example, the effect of green shoots persisted in the next generation it would be injurious to the great majority of the larvæ, for the parent moth generally lays her eggs on plants with dark twigs. The same argument applies to the smaller differences which distinguish

the dark twigs of various trees from each other; for these also are reproduced upon the larvæ. Thus Mr. Arthur Sidgwick has shown that the caterpillars, when found upon birch and oak, differ, as do the dark twigs of these two trees (l.c. p. 360). It has not yet been shown that any Membracid has this power of adjusting its colour to two or more environments, so that my argument does not at present apply to these insects. If, however, it is at all possible to breed them it would be deeply interesting to ascertain whether any such adaptability exists. The best chance of success would be afforded by experiments upon well-concealed species of which the individuals are known to vary greatly, but always in the direction of some one of their natural environments.

It is now proposed to make a brief survey of the material illustrated in this monograph and to attempt to suggest the possible bionomic meaning of the appearances into which the enveloping pronotal shield is fashioned in the various groups of species.

Commencing with the sub-family *Membracinæ*, the genus *Membracis* includes the species with the pronotum high and compressed from side to side, and coming to a sharp thin edge like a leaf. Beneath this leaf-shaped structure, which is dark, mottled with white or yellow, the head, wings, and legs of the insect are seen (see Plates I. and II.). Inhabiting the same part of the world, tropical America, in which alone this genus is found, are ants of the genus *Ecodoma* (Sauba ants). The ants live upon fungi which they cultivate in galleries underground, growing them upon a paste of bitten-up leaves. To provide this soil streams of ants are continually passing to the formicarium, each bearing a piece of leaf held vertically in its mandibles and thrown back over the body. The ants are extremely common, so much so indeed that certain kinds of imported trees cannot live in that part of the world, and the processions of leaf-carriers as well as the single ants are among the most familiar and characteristic of sights. The *Membracidæ* on the other hand are scarce. Green leaves are not the only things sought out by the ants; they have been seen carrying off parts of the wings of butterflies, as well as leaves discoloured in various ways.

It seems possible that the rare *Membracis* with its high laminar pronotum may pass undetected among the numerous leaf-carrying ants which are partially concealed beneath their burdens in much the same manner. Furthermore the pronotum is about the same size as the fragment of leaf and the Membracid as some of the forms of the worker ants.

I do not desire to press this interpretation with confidence, but merely bring it forward as a suggestion. I venture to hope that naturalists visiting tropical America will observe whether the leaves carried by the ants do not sometimes possess the curious parti-coloured appearance of the Membracid pronotum.

The larvæ (Plate II. Fig. 4a) of the species of this genus are described by Canon Fowler in the *Biologia Centrali-Americana* as "very curious, being of much the same shape as the perfect insect, but formed of separate upright narrow plates of different heights." That these larvæ protectively mimic the leaf-carrying ants is highly probable, far more so than in the case of the mature insects; for we have here the testimony of a biologist who observed the living insect in its natural habitat. Mr. W. L. Sclater, on returning from his journey to British Guiana in 1886, told me that on one occasion while collecting insects by shaking the branches of a tree over a sheet, his native servant, whom he described as a very acute observer, mistook one of these Membracid larvæ for a "Cooshie ant" carrying its fragment of leaf. Mr. Sclater brought the larva home, and it is figured in a short paper communicated to the Zoological Society (P.Z.S. 1891, p. 462, Plate XXXVI.). In this case we know that the thin flattened body is of a green colour like a leaf, while beneath it the legs and head are brown like the part of the ant which is not concealed by the leaf.

It is of great interest that the remarkable forms of larva and perfect insect—although superficially alike—are produced in entirely different ways. In the larva the thin flattened shape is due to compression of the whole of the body rings behind the head, and every one of them contributes to form the sharp dorsal line which so much resembles the serrated margin of a leaf or a jagged edge gnawed by the mandibles of the ant. The same sharp line, forming a smoother sweep, is, in the perfect insect, made up by the edge of the pronotum alone. If, therefore, both larva and imago resemble leaf-carrying ants, the part representing the leaf is made up by all the segments in the one, and by the pronotum alone in the other. Both larvæ and imagos probably live in the trees which the ants frequent for the purpose of cutting the leaves.

At first sight it seems very difficult to account for the origin of such a case of protective mimicry, if indeed the interpretation here suggested be correct. It is, however, probable that the thin green body-form was gradually evolved to promote concealment among leaves, and that the few special details which suggest the ant were subsequently added.

It is also of much interest that forms superficially resembling *Membracis* should be found in the Orthopterous genus *Xerophyllum* (Plate I.) where the dead-leaf-like appearance is not confined to the pronotum but is further carried out in the legs and head. The resemblance is clearly incidental and syncryptic.

The appearance of the genera *Phyllotropis* and *Cryptonotus* (Plates III. and IV.) is not unlike that of *Membracis*. In the genera *Enchophyllum* and *Enchenopa* (Plates IV. to VI.) the pronotum is prolonged into a horn anteriorly, in some species bent,

and in others straight. The shape and appearance probably promote concealment in trees and shrubs. *Tropidocyta* and *Leioscyta* (Plate VII.) are very similar to the above-named genera, but the pronotum is not foliaceous and is rounded or very obtusely pointed anteriorly. They are probably adapted to concealment among plants, resembling buds or the irregularities of rough bark.

The irregular rounded species of the genus *Tylopelta* (Plate VII.) would also be well concealed on rough bark, while on the ground they would resemble seeds, the excrement of larvæ, or small lumps of earth. Some of the elongated and generally curved forms of *Philya* and *Scalmophorus* (Plate VIII.) suggest small bits of stick, of which the projecting end appears to be broken off, while the species in which the pronotal horn is pointed anteriorly perhaps represent thorns. The greatly varied shapes presented by the genus *Hyposoprora* (Plates VIII. and IX.) suggest protective resemblance to vegetable growths of various kinds—buds, roughened bark, irregular or winged seeds.

The next genus, *Bolbonota* (Plates IX. and X.), contains small, dark, roundish insects closely resembling seeds, also small lumps of earth, &c. They would be well concealed upon rough bark. The pronotum, which is the only part seen when the insect is looked at from above, is rounded and broad and its surface deeply sculptured. In the position of rest the legs are folded close to the body, and thus help in the disguise. Canon Fowler remarks in the *Biologia*: “No insect could look more unlike the foliaceous species of *Membracis*, and yet, so gradual and so complete is the transition through intermediate species, that the older authors included them under the same genus.” *Bolbonotodes* (Plate X., Fig. 9) includes an allied insect, which is also seed-like in appearance.

Pterygia, with its remarkable winged processes and strongly roughened surfaces (Plates XI.—XIII.), appears to be undoubtedly cryptic, resembling some of the forms of the vegetable environment. What these exact forms are must be determined by naturalists upon the spot, but lichen, winged seeds, and the irregularities of extremely rough bark may be suggested. Almost the same words may be used of the astonishing forms presented by the remarkable genus *Sphongophorus* (Plates XIII.—XV.), some of which seem clearly to suggest lichen, and others the excrement of birds or other animals, as is indicated by Mr. Buckton (see description of Fig. 4 on Plate XIV). A possible resemblance to galls should also be taken into account. The remarkable inflated part of the pronotum of *Sphongophorus inflatus*, figured by Canon Fowler on Plate III., Fig. 5, of his monograph in the *Biologia*, bears a peculiar sculpture which may be gall-like. The species are, as Canon Fowler writes in the *Biologia*, “among the most extraordinary of the *Membracidæ*, and, in fact, there are few insects which assume more curious forms.”

I can imagine no more interesting study for the tropical American naturalist than the attempt to discover the meaning of these remarkable shapes by careful observation of the living insects under as many different conditions as possible, and especially during the periods of prolonged rest and entire quiescence. It is during these latter times rather than in periods of activity (including the frequently repeated brief intervening pauses) that the true meaning of a cryptic appearance and instinct is to be sought. Thus insects which are about by day should be watched going to rest, and then observed from time to time during the hours of darkness; conversely, nocturnal forms should be tracked and then watched by day. Insects which require the hottest sunshine should be studied in exceptionally cold cloudy weather, &c. In thus looking out for the times of complete repose, when a cryptic appearance is of the highest importance, Mr. Nelson Annandale's observations in Malacca (1899-1900) should be remembered. He informs me that insect-eating animals retire to rest during the hottest hours of the day, and that at this very time insects, including such cryptic forms as the stick-like Phasmids, move about freely, assume positions and occupy environments in which they are quite conspicuous. Any observer who neglects to take account of this aspect of the question can only commit himself to random criticism like that which has been often urged against the interpretation of the wonderfully cryptic underside of butterflies of the genus *Kallima*. Because these insects have been seen in conspicuous positions and attitudes during the short pauses between successive flights it has been argued that the dead-leaf-like underside cannot be for concealment. Let any such observer watch a *Kallima* to rest at the close of a day's active flight, and his notes and criticism on the subject will have value. As it is we are only confronted by the aimless objection that an adaptation developed for one purpose is not made use of for another, and with this conclusion the movements and attitudes of our English *Vanessidæ*, with their cryptic undersides, had long ago familiarised us.

We now reach the second sub-family of Mr. Buckton's classification, the *Hoplophorinæ*. The cryptic resemblance to thorns in the genus *Umbonia* (Plates XVI. and XVII.) is well known, but here, too, exact observation of the living insects is much wanted. The manner in which the red stripes are developed on the green or greenish thorn-like pronotum is very realistic and convincing. The fact that the females are far more completely thorn-like than the males (compare Figs. 1, 2, 3 with 4 and 5 on Plate XVI.) may be merely another example of the general principle that the latter sex, when it differs from the former, is more cryptic or more completely mimetic, as the case may be. The greater needs of one sex have been met by increased perfection in those adaptations which are the chief means of defence.

The remaining genera of the *Hoplophorinæ*, figured by Mr. Buckton, viz., *Triquetra*,

Microschema, *Hoplophora*, *Platycotis*, *Potnia*, and *Ochropepla* (Plates XVIII.-XXII.), also suggest cryptic resemblance to various vegetable structures, as a reference to the figures will sufficiently indicate. As in almost all the other cases the bionomics of each of the species requires special study upon the spot. In *Hoplophora sanguinosa* (Plate XIX., Fig. 3) Mr. Buckton suggests the resemblance to a small bee. A probable model may be found by a search among the Neotropical HYMENOPTERA ACULEATA, but observation of the living insects will still be most desirable in order to afford the fullest confirmation of the interpretation.

In the two sub-families, the *Membracinae* and the *Hoplophorinae*, cryptic appearances seem to be almost universal, so far as we can judge from the more or less probable interpretations suggested by a study of cabinet specimens and figures. We now reach the *Darninae*, a sub-family in which mimetic adaptation is the probable explanation of many species. Passing the genus *Aspona* (Plate XXII.), of which the colouring may be cryptic, we reach the contrasted colours and conspicuous patterns of *Darnis* (Plates XXII. and XXIII.). It is highly probable that the appearances which are here figured, indicate aposematic (warning) colours, or else mimicry of the warning colours of other animals. It is probable that one or more of the unpalatable groups of COLEOPTERA, such as the Phytophaga or the *Coccinellidæ*, afford the models for some of the species, and it has been suggested that others are mimetic of slugs (see page 109). Certainty can only be attained by a study on the spot, but some conclusions with a high degree of probability could, I think, be reached by an examination of a good museum collection of the specially protected COLEOPTERA from the same part of the world. Some of the species of the genus *Stictopelta* (Plates XXIII. and XXIV.) are also probably mimetic of COLEOPTERA. The representation of *S. nigrifrons* (Plate XXIII., Fig. 5) especially suggests the appearance of a beetle, such as one of the Phytophaga, with a reddish head, black thorax, and light brown elytra. Other species of this genus possess colours which may be cryptic, and the same is the case with *Hebeticoides*, *Hebetica*, *Tropidarnis*, *Alcmeone*, *Hyphinoë*, *Darnoides*, *Dysyncritus*, *Aconophora*, *Entaphius*, *Hypheus*, *Hemiptycha*, *Nessorhinus*, and *Cymbomorpha* (Plates XXIII.-XXIX.). The cryptic interpretation is highly probable in some of the species figured, less certain in others. Thus Mr. Buckton's suggestion that *Hebeticoides acutus* (Plate XXIII., Fig. 8) resembles a shining brown seed (page 119), or, at least, some vegetable structure, is in every way probable, as is the bud-, thorn-, or spine-like interpretation of several species of *Aconophora*. A single figured species of this latter genus, *A. W—album* (Plate XXVIII., Fig. 5), appears to possess an aposematic or mimetic colouring. Again, the species of *Alcmeone*, *A. centrotoides*, shown on Plate XXIV., Fig. 6, appears to be cryptic, while *A. godmani*, figured by Canon Fowler on Plate V., Fig. 24, of his monograph in the

Biologia, is justly described by Mr. Buckton as "one of the most conspicuous amongst the *Membracidæ*" (p. 111). The figure strongly suggests warning or mimetic colouration, but a possible cryptic resemblance to a brilliant fungus, fruit, or flower-bud, should not be left out of account in the search for an interpretation.

In *Heteronotus* (Plate XXX.) the resemblance of the pronotal shield to an ant has already been noted. The relation of the ant-like mask to the insect as a whole is well seen in the various figures of Plate XXX. Thus, the dorsal view shows only the mask with wings and legs and part of the head (Figs. 2 and 6a). The lateral view shows no more when the wings and tegmina are somewhat opaque, and are represented in the position which is probably natural during rest (Figs. 1, 3, 4). When they are more transparent, as in Fig. 6, the abdomen may be seen through them, but it is probable that in the natural attitude this part of the body would be raised, and thus, at least, partially hidden by the underside of the mask. When, in a drawing of the side-view, the wings are represented as raised (Figs. 2a and 5), or when the insect is drawn from below (Fig. 4a), the true relationship of mask and insect proper is seen, and the entirely Homopterous character of the insect, as a whole, in spite of its Hymenopteron-like shield, will be at once appreciated. In *Heteronotus trinodosus*, figured in Canon Fowler's monograph in the *Biologia Centrali-Americana* (Plate VI., Figs. 16, 16a, and 17), a bead-like dilatation is present in the part of the shield which represents the peduncle or stalk connecting the thorax and abdomen of an ant. This structure is evidently in mimetic resemblance of the bead-like enlargement of the peduncle in the *Myrmicidæ*, the family of stinging ants which are specially characteristic of South America. This interesting detail in the likeness between model and mimic was pointed out to me by Mr. W. F. H. Blandford. Mr. Buckton considers that some of the species of this genus mimic striped spiders. If this be the case the resemblance would probably be to spiders which are themselves mimetic of ants, as are many of the *Attidæ*. Observation upon the spot is, above all, necessary in order to settle the question; but should it hereafter be decided in the affirmative, another example would probably be added to the many known instances of that secondary likeness between the mimics of some primary model which appears to be a sure indication of Müllerian (synaposematic) resemblance (*Trans. Ent. Soc. Lond.*, 1902, pp. 511-515). Another interesting subject which must be studied upon the spot is the investigation of the movements and habits of the mimetic *Membracidæ*, and especially these ant-like forms. Mimics of ants are, as a rule, markedly ant-like in their movements, and we should expect this to be the case with the *Membracidæ*, but so far as I am aware no special observations have been made upon them.

The concluding genus *Combophora*, and sub-genus *Anchistrotus*, of the *Darninæ*

seem also to be mimetic, as a glance at Plates XXXI. and XXXII. will suggest. The model of *Combophora beskii* (Plate XXXI., Figs. 1 and 2) appears to be a *Coccinella* or a *Coccinella*-like beetle. But the pattern is so strongly developed and conspicuous as to raise the suspicion of independent unpalatability and Müllerian association. The simple effective Coccinelloid type of pattern and colouring is probably easily reached by variation and selection, and is certainly prone to attract specially protected forms of the most varied affinities into synposematic groups (see *Trans. Ent. Soc. Lond.*, 1902, p. 520, and *P.Z.S.* 1902, pp. 268, 270). Another very conspicuous species of the genus *Combophora*, viz., *C. tridensis*, is also represented (Plate XXXI., Figs. 5, 5a). The appearance, together with that of the form of *C. beskii*, shown in Fig. 2, suggests an example of warning colours or mimicry, and the same interpretation probably holds for the other types of colouration represented in Plate XXXI.—the species of *Combophora*, shown in Figures 3, 6, and 7, and *Anchistrotus obesus*, seen in Fig. 4. As regards the latter the white patch on the dark tegmina seems especially suggestive of mimicry or warning colours.

Looking back on the *Darninæ* we are led to believe that at least much of the mimicry in the group is Müllerian rather than Batesian, because of the tendency of the resemblances to appear throughout whole genera, and because the colours and patterns of many species have a marked conspicuousness of their own.

The small fourth sub-family, the *Tragopinæ*, is illustrated on Plates XXXII. and XXXIII. by the genera *Tragopa*, *Chelyoidea*, and *Horiola*. The group is probably mimetic, as Mr. Buckton suggests on p. 155; but the conspicuous distasteful groups among the Neotropical RHYNCHOTA, as well as COLEOPTERA, should be investigated for probable models. The shapes shown in Plate XXXII., Figs. 8 and 9, and Plate XXXIII., Figs. 1a and 2, seem especially likely to resemble those of other distasteful RHYNCHOTA. Here too the Müllerian interpretation seems the more probable.

The fifth sub-family, the *Smiliinæ*, is a very large one. The most remarkable of all the species of this remarkable section of the HOMOPTERA are to be found here in *Cyphonia*, and in the genera *Bocydium* and *Æda*, placed by Mr. Buckton between the *Smiliinæ* and the *Centrotidæ*.

The remarkable combination of filaments and dilated spheres developed by the pronotum in certain species of the genus *Cyphonia* (Plate XXXIII., Figs. 4, 5, 6, 7, and 7a), may be compared with the still more extraordinary and complex structures in *Bocydium* (Plate XLV., Figs. 6, 7, and 8; Plate XLVI., Figs. 1, 2, and 2a). In the absence of observations on the spot, the most probable interpretation is to suppose a cryptic resemblance to some vegetable structure, such as a spined fruit or seed specially adapted for anchorage in the fur of animals; or some complex development of thorn or spine. When we consider how far the Neotropical Region surpasses the

rest of the world in the amount and variety of mimetic resemblance in insects we see the outcome of a selective environment which may well have developed cryptic forms more strange and complex than any that are known elsewhere. But the possibility of mimetic likeness in *Cyphonia* and *Bocydium* should not be left out of account in the attempt to solve the problem. The fact that no undoubted explanation is forthcoming is by no means surprising; and even when the living insects are studied under natural conditions it is quite likely that a solution may be long delayed. Every English entomologist has known from boyhood the "Comma" or "C" on the underside of the wings of the butterfly *Grapta C-album*; yet the explanation of a cryptic resemblance to the light seen through a semicircular crack in a weather-beaten fragment of dead leaf, although sufficiently obvious when once stated, was only given a few weeks ago (*Proc. Ent. Soc. Lond.* for May 6, 1903). The writer hopes that Mr. Buckton's figures of species of these two genera may induce naturalists in South America to make a special effort to solve this deeply interesting problem. The observer should keep a very open mind and not neglect effects produced by communities of individuals of the same species, nor the possibility that a single Membracid surmounted by the branching appendages of its pronotum may resemble a combination of two quite different forms, such as an ant or spider attacking or carrying its insect prey. Figs. 4, 5, 6, and 7 on Plate XXXIII., and 1a on Plate XXXIV., should be looked at from this point of view.

Passing to other genera, *Poppea* (Plate XXXIV.) presents structures similar to *Cyphonia*, but on a somewhat smaller scale. In *Ceresa*, *Stictocephala*, *Centrogonia*, *Phacusa*, *Eurytea*, *Acutalis*, *Micrutalis*, *Trachytalis*, and *Polyglypta* (Plates XXXV.–XXXVIII.) we meet with shapes and colours, which generally appear to be explicable without difficulty as examples of protective (cryptic) resemblance to common plant structures. Species of the last-named genus (Plate XXXVIII.) appear to resemble elongated fruits or seeds, although the idea of mimicry of a Brenthid beetle should be tested by observation before being dismissed. *Entylia*, *Pubilia*, *Metheisa*, and *Oxygonia* (Plates XXXIX. and XL.) are probably to be explained in the same way, in some cases resembling roughened bark or irregular fruits or seeds, in others perhaps buds.

Parantonaë dipteroides (W. W. Fowler), figured by Canon Fowler on Plate VII., Figs. 10 and 10a, of his monograph in the *Biologia*, is apparently a beautiful mimic, and the aculeate HYMENOPTERA of its sub-region (Central America) should be examined for possible models. Figured with wings outspread the superficial resemblance to a fly is undoubtedly strong, but the effect upon the contour of the dark coloured basal half of the depressed tegmina must be taken into account. Canon Fowler in stating (p. 102) that the species "has the appearance of a *large*

fly" (italics mine), seems to have been influenced by the magnified representation on Plate VII.

In *Adippe*, and perhaps *Argante* (Plates XL. and XLI.), mimetic resemblances or warning colours are again suggested, the most probable models being the conspicuous unpalatable groups of COLEOPTERA. As in so many other cases the extreme conspicuousness suggests the Müllerian rather than Batesian form of mimicry. Protective resemblance to plant structures of various kinds appears to be the interpretation of nearly the whole of the next set of genera, some of which had been also illustrated in earlier plates: *Godingia*, *Antianthe*, *Cyrtolobus*, *Hille*, *Theia*, *Pubilia*, *Aymna*, *Stictocephala*, *Telamona*, and *Heliria* (Plates XLI.–XLIII.). *Gibbomorpha* (Plates XLI. and XLII.) however appears to be more conspicuous and may be aposematic or mimetic. Some of the species of *Telamona*, figured on Plate XLIII., viz., *T. sinuata*, *albidorsata*, and *turritella*, also possess a remarkable colouring which requires investigation in the natural surroundings.

The genera next represented in the plates are those considered as introductory to the *Centrotidæ* proper (p. 205). *Lycoderes* (Plates XLIII.–XLV. and XLVII.) includes species some of which (XLIII. 8; XLIV. 5, 6; XLV. 1, 2) are probably concealed by resemblance to plant structures, while others appear to possess warning or mimetic colours (XLIV. 1, 2, 3; XLVII. 4). *L. burmeisteri* may be mimetic of some other conspicuous distasteful Homopterous insect, such as a Fulgorid. In the remarkable genus *Æda* (Plate XLV.), the pronotum forms a huge inflated sac, the orange-coloured walls of which are transparent and marked with lines due to the existence of a branching network. Mr. Buckton considers this appearance to be leaf-like (p. 205); but it is more probably a case of protective resemblance to the curious cocoons of certain Neotropical moths, which are constructed of an open network of coarse silken strands of an orange colour. The colour of *Æda inflata*, as shown in Plate XLV., Fig. 4, is too dark and opaque to indicate this resemblance. It is, however, sufficiently clear in Erich Haase's, Plate XIII., Figs. 112 and 113 (English translation "Researches on Mimicry," &c., Pt. II., Stuttgart, 1896). Haase himself considered that the insect resembles the empty pupal shell of a butterfly. The entire passage from the original work (Stuttgart, 1893) is as follows: "Ein anderer anscheinender Grenzfall gehört dagegen sicher in die Kategorie der 'Schützenden Aehnlichkeit.' Derselbe betrifft eine merkwürdige neotropische Buckelzirpe *Smilia (Oeda) inflata*, F., deren Nackenschild von blasigen Hohlräumen durchzogen ist und den winzigen Körper von oben vollkommen verdeckt. So gleicht das auf einem Blatte oder an einem Zweige meist ruhig sitzende Thier durchaus der leeren Puppenhülse eines bereits ausgeschlüpften Tagfalters." The English translation, by M. C. Child, is as follows: "Another apparently transitional case belongs

in reality to the category of 'protective resemblance.' This is the case of a peculiar Membracid, *Smilia (Eda) inflata*, F., whose pronotum is traversed by sac-like hollow spaces, and completely conceals the tiny body when seen from above. Thus, this insect, which usually sits quietly on a leaf or twig, resembles very closely the empty pupal case of a butterfly."

Passing the astonishing genus *Bocydium*, which has been already discussed on pp. 282, 283, we reach the remarkable genera *Hypsauchenia*, *Micreune*, *Anchon*, *Kleidon*, and *Elaphiceps* (Plates XLVI.-XLIX.). The extraordinary developments of the pronotum in these genera, together with its less specialised form in *Lamproptera* (XLVII., 5), probably serve to conceal the insects by their resemblance to vegetable structures.

The *Centrotidæ* are also abundantly illustrated in this monograph, no less than thirty-four genera being represented by figures, and often many figures, upon the concluding series of plates (XLIX.-LX.). It is not necessary to say much about them, for a glance at the plates will indicate that the forms and colours are in almost all cases such as we should expect to resemble plant structures. There are a few possible exceptions, such as the very dark-coloured species of *Centrotypus*, *Daimon*, and *Ibiceps* (Plates LIV., LV.), in some of which the conspicuousness is further heightened by the contrast with pale markings. But it is impossible to feel confident that some, or even all, of them may not be concealed by resemblance to some special form of environment.

In conclusion, I desire again to call attention to the fact that with few exceptions the foregoing remarks are merely suggestions intended to serve as indications to the naturalist on the spot, and are in no sense dogmatic utterances. I feel that in this most remarkable group of insects the examination of figures, or even of the specimens themselves in a museum, can only occasionally afford us the foundation for a valuable opinion as to the bionomic meaning of the forms, colours, and patterns. But such an examination continually suggests possible interpretations which may lead the observer of the living species to think, and may sometimes even direct him into the right track. It was in the hope that such success might be achieved from time to time that I was glad to accept Mr. Buckton's courteous invitation to contribute this section to his interesting monograph.

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