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Zoology. — *"The colourpattern on Diptera wings."* By Prof. J. F. VAN BEMMELEN.

(Communicated in the meeting of March 31, 1917).

The investigation of the colour patterns on the wings of Lepidoptera brought me to the conviction, that in their markings original and modified motives of design could be distinguished, the first being arranged in strict dependency on the nervural system and in regular repetition over the whole of the wing-surface. This result foreshadowed the probability, that on the wings of other orders of insects similar arrangements of pattern might be met with, which would allow of a similar distinction between a primordial pattern and its later or secondary modifications: the primitive pattern in the same way being directed by the course of the veins in its distribution over the wing-surface. And as the comparative investigation of the nervural systems in different orders of insects had led to the final conclusion that all of them represent modifications of one common groundplan, the supposition that a similar fundamental connection might exist between the primitive colour-markings, occurring between those nervures, became extremely probable [1]).

Starting from this supposition, J. BOTKE [2]) argued, that the similarity between the colour-pattern on the wings of Cossids, Micropterygids, Hepialids and other Lepidopterous families, and those of Trichoptera and Panorpata, should not be considered as a merely accidental resemblance, but depended on a real homology. Evidently it is worth while to extend this investigation to the remaining Insect-orders.

That I take the Diptera as a starting point, is in no way due to the opinion, that a near relationship exists between this order and Lepidoptera, nor is it because I should consider the Diptera as especially primitive insects; it is in consequence of a recent (1916) publication by J. H. DE MEIJERE: Zur Zeichnung des Insekten-, im besonderen des Dipteren- und Lepidopteren-flügels, in which he has treated these two orders in succession, and noted equivalent features in them, though he has carefully abstained from drawing comparisons between them in details.

Now DE MEIJERE does not acknowledge my distinction between primary and secondary wing-markings, nor does he accept the

[1]) Vide NEEDHAM and COMSTOCK, The wings of Insects, American Naturalist, 1898.

[2]) J. BOTKE, Les motifs primitifs des ailes des Papillons et leur signification phylogénétique. Onderzoekingen verricht in het Zoöl. Lab. der Rijks-Universiteit Groningen V, 1906, Tijdschr. d. Ned. Dierk. Ver. 2de Ser. Dl. XV.

assumption of a similarity rooted in community of origin. On the contrary, as he considers absence of colour to be the primitive condition in Diptera, he believes in "the probability of an independent origin of colour in many different points of the group, because we meet coloured wings in so many and such different families."

But though he thinks that these different colour-patterns have arisen independently of each other, he accepts a connection between them in so far that he believes special regions of predilection for colour-formation to be indicative. These regions being either the nervures themselves, or the spaces between these nervures, his observation may be regarded as confirmation of my opinion, that the colour pattern is originally bound to the nervural system. The same may be said of the evident predilection for pigment-accumulation along the wing-margins and at its root.

I likewise fully agree with DE MEYERE, where he ascribes the formation of coloured transversal bars in many cases to the broadening of colour-seams along transverse veins, as well as when he attributes the cloudy "fumigation" of wing-areas to an extension of spots or blotches (which therefore originally must have been smaller).

All these phenomena may be considered as manifestations of the different manner, in which an original pattern can become modified and differentiated. The same is the case with the transformation of spots into transverse stripes, or the coalescence of two spots on either side of a nervure into one single blotch, which consequently will become divided by the vein.

The final proof that the more complicated patterns on coloured Dipterous wings may justly be considered as differentiations of one common primitive design bearing a simpler and more regular character, can only be obtained by showing that the formation of the definite pattern is preceded by the temporary presence of a preliminary pattern, possessing the above mentioned more primitive character; that is the same proof as I was able to obtain for Lepidoptera. But in expectation of this ontogenetic proof, it is allowable to heighten the probability of the supposition by adducing arguments founded on the comparison of fullgrown forms, which in the mean time may furnish us with a reliable image of this primitive pattern. For this purpose we have to start from the comparison of species belonging to the same genus, or to nearly related genera, and, having come to a conclusion about their ancestral form, to compare this with a similar one of various genera belonging to another family.

It might reasonably be supposed, that the chance of encountering a more primitive design would be greater in forms provided with a more original nervural system, which in Diptera is equivalent to a more complete one. However I hope to be able to argue that this is not necessarily the case.

Notwithstanding this I think it is preferable to start from forms with a less modified nervural system, e.g. the genus Haematopota, containing a number of species, whose wings show a rich but at the same time regular ornamentation.

Comparing the four species: italica, tuberculata, pluvialis and maculata, it is beyond doubt, that in all of these the colour-markings are arranged according to the same groundplan, which in italica, pluvialis and tuberculata is more fully and regularly developed than

Fig. 1. Haematopota pluvialis.

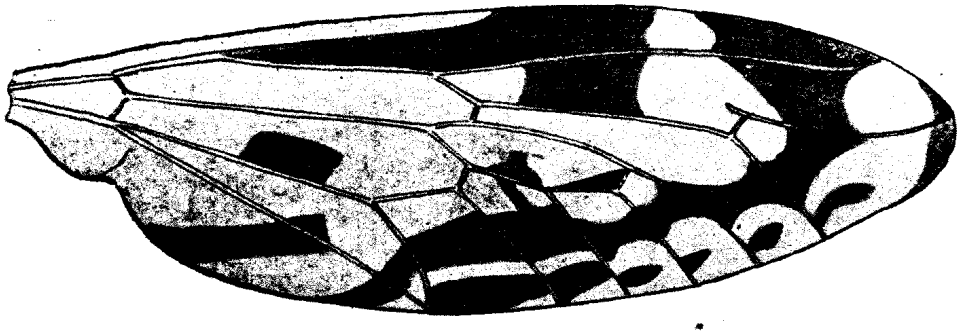

Fig. 2. Haematopota maculata (De Meijere).

in maculata, the latter showing the proximal half of its wings almost destitute of markings, except a few irregular patches, while the distal part contains two transverse rows of dark markings, those of the outer row being smaller and more isolated, those of the inner (submarginal) broader and connected to a continuous band.

In both parts however the extension of the markings is limited by

the nervures and whenever they seem to pass these limits, the real cause lies in the meeting of two independent markings of similar extent along the course of a vein.

Fundamentally therefore the features on Haematopota-wings are identical with those we could remark on the wings of Hepialids amongst Lepidoptera: viz. an almost perfectly regular alternation of dark and light patches, filling out the areas (cells) between the nervures, but not passing over their borders, and occurring in like numbers in successive internervural cells, which necessarily brings about their arrangement in transverse rows parallel to the external wing-margin.

In those wingparts, where the regularity of the pattern is interrupted, we clearly see the modification by which this is brought about, e.g. where two neighbouring transverse markings are coupled together by a longitudinal bar, or where they curve over into each other.

Though I hesitate in ascribing importance to the configuration of the single markings, I will not abstain from pointing out the remarkable similarity between the dumbbell-shaped light markings of Haematopota italica (corresponding to paired triangular markings in H. tuberculata), and the hourglasses of Hepialids.

The comparison of these four species of the genus Haematopota therefore leads to the conclusion, that the original condition of their wings is not the uncoloured state, but on the contrary that of a complete pattern extending over the whole wing surface, and consisting of light and dark patches in regular alternation, arranged between the nervures, alike in size and placed at equal distances, so as to compose zigzag-ranges of markings, transversely running in a direction parallel to the external wing-margin. In all these features therefore the pattern corresponds to that of Hepialids, Zeuzerids, Trichoptera and Panorpata.

Judging by v. d. Wulp's figure (Tijdschrift voor Entomologie Vol. 17, Pl. 8), the wing of Poecilostola angustipennis satisfies the above mentioned criteria for a primitive colour-pattern, in still higher degree than that of the Haematopotas; viz. in strict dependency on the course of the nervures and regular repetition of the same motive of wing-design. For here all internervural cells contain longitudinal series of numerous small spots, arranged all along both sides of the nervures. It is only in the third cell from behind, viz. that situated between first cubital and first anal nervure, that a third range of spots is seen along the middle-line of the cell, where the 2^{d} cubital vein would be found, had not that nervure obliterated.

In Poecilostola punctata (fig. by GRÜNBERG, Diptera, in BRAUER's Süsswasserfauna Deutschlands, p. 57) a similar median row of small spots is seen between first and second anal nervure, thus giving ground for the supposition that here also a vein may have been

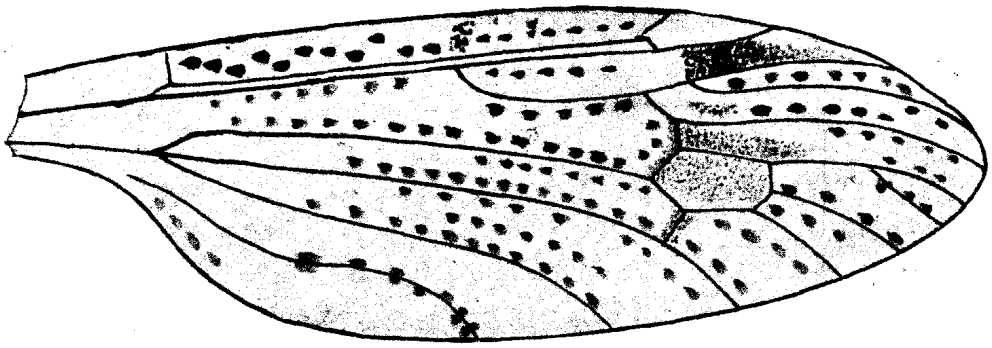

Fig. 3. Poecilostola angustipennis, (VAN DER WULP).

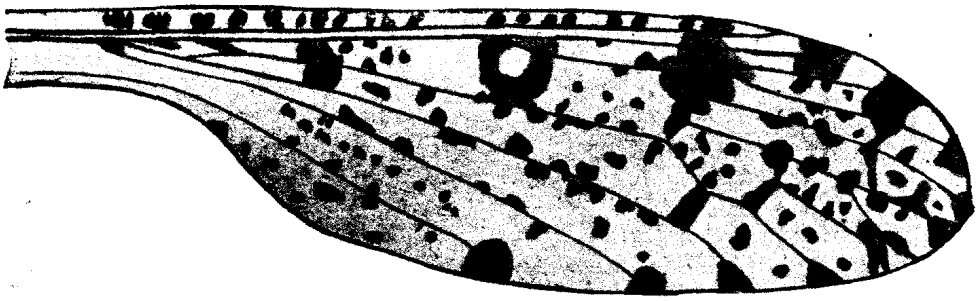

Fig. 4. Poecilostola punctata, (MEIG).

obliterated, viz. An_2. But at the same time amongst the small spots, which are arranged in rows, we find a number of larger ones distributed, some of them showing an irregular configuration, as if they had arisen by the coalescence of a certain number of smaller ones. These bigger spots lie in the first place at the end of the longitudinal veins, in the second place on forkings and junctions.

Extending our comparison to Acyphona maculata (GRÜNBERG p. 29) we find here all the above mentioned bigger spots, arranged in the same way, while the smaller ones with a very few exceptions, are absent. This suggests the conclusion, that the absence of the small spots is caused by their obliteration.

Further extending our investigations to forms with a reduced nervural system, e.g. members of the genera Tephritis, Sciomyza and Traginops, we see the same feature as in the Haematopotas, viz. regular alternation of light and dark patches, arranged in rows along the veins, but modified and complicated in so far as either

a dark or a light streak extends over the middle of several internervural cells, with which in the first case the dark nervural spots, in the second the light ones may be connected. This distribution of the colour therefore brings about two different effects: when the median is dark the uncoloured areas present themselves as light

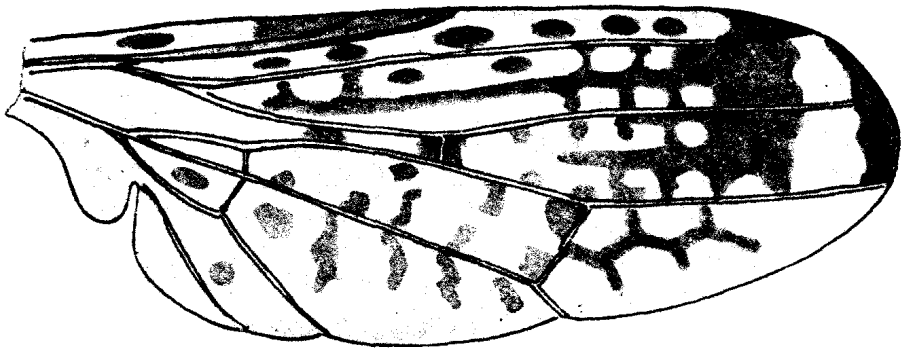

Fig. 5. Sciomyza javana (de Meyere).

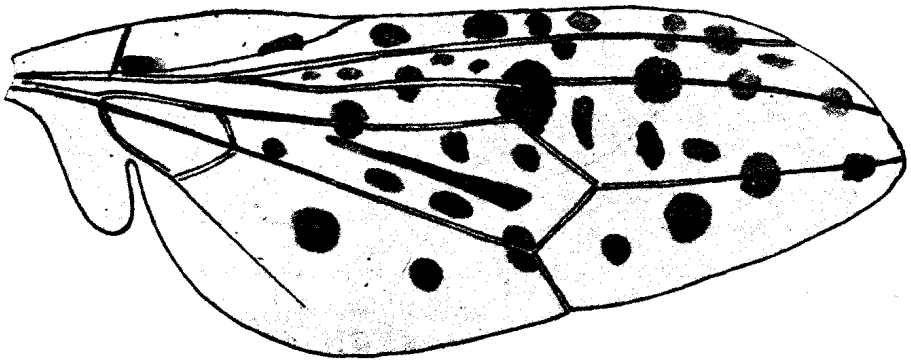

Fig 6. Traginops orientalis.

spots on a coloured background, when it is light the pigmented areas form dark spots on a light field. Yet both patterns are varieties of the same groundplan, as may be seen by comparison of different species belonging to the same genus; e.g. Tetanocera vittigera, showing dark spots on a clear wing-surface and T. umbrarum, with light spots on a dark ground. But the same conclusion can be drawn from the consideration of different areas of the same wing: one internervural cell containing a dark median bar with light spots at either side, a neighbouring one the opposite arrangement, or even the proximal half of one such cell differing in this respect from the distal one.

Though number as well as size of the spots is found to be inconstant, I am inclined to assume, that also in these respects a funda-

mental condition exists, while the deviations must be explained either by coalescence of dark spots to larger coloured areas, or on the contrary by reduction of the pigmented parts, bringing the light areas into predominance. Also in these animals the proximal half of the wing generally is the less coloured, showing fewer and smaller spots, resulting in their total absence in the departments of lobus and alula.

Turning to those cells, which contain either a dark or a light median streak, these are seen to be precisely those which may be supposed to have been formed by coalescence of two neighbouring internervural areas, by the obliteration of the nervure originally separating them. In Sciomyza javana, which shows these dark median bars to perfection, they stretch along the spaces, which in Diptera with a more complete nervural system are occupied by the fourth radial and the first median vein. We therefore are justified in assuming, that we have here the same phenomenon which is seen in Lepidoptera-wings (esp. Papilionids and Danaids), where the course of obliterated veins in the discoidal and cubito-anal cells is marked either by black or by light streaks of pigment.

De Meyere also has given his attention to the pigmentation of the median streaks in internervural cells, for he says on p. 58: [1]) In the cells of Diptera-wings median rows of spots occur relatively seldom in typical array. As examples may be given: Sciomyza Schönherri, Hydrophorus nebulosus (between the 1st and 2nd and the 2nd and 3rd longitudinal vein respectively, while pigmentation of the end of the nervures, seams of colour along transverse veins, and traces of a double row of spots in the upper part of the middle of the hindmarginal cell also occur), Ilythea spilota, Scatella quadrata, furthermore some Pterocallines. In several species related to the first mentioned ones especially among Tetanocerinae, the median spots are well marked in the hindmarginal cell, a double row of spots occurring in the remaining longitudinal cells. As in Schönherri the spots often already appear as transverse streaks, and as in other cases there is an evident connection between two spots lying one above the other in the same cell, as indicated by their position, it is my opinion, that such a double row of spots must be considered as resulting from the division of a median row. I may cite a typical example in Tetanocera (Pherbina) punctata, which at the same time shows a further feature, viz. *a median longitudinal streak in the cells*".

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[1]) Translated from the German original by me.

And on p. 69: "Interesting features are shown by the Sciomyzidae. Many of their species show colourseams of the transverse veins; pigmentation of the longitudinal veins is found in Tetanocera elata, Elgiva lineata, of the anterior margin in T. elata. Marked punctuation occurs in numerous forms, e. g. T. punctata; the points usually being arranged in one row in the hindmarginal cell, in two rows in the remaining cells. These rows lie along the side of the nervures, or in other words, each nervure lies between two rows of spots: the spots to either side often corresponding to each other, though not always; also the spots placed along the two borders of the same cell frequently form pairs. On page 58 I argued that I consider these two lateral rows of spots as derived from the division of one median row. In T. punctata an accessory median bar is only slightly developed, but in other species this bar and the lateral spots are intimately connected; coryleti and unguicornis already show this connection more clearly than punctata and marginata, fumigata etc.; it leads to preponderance of the dark colour, only two rows of hyaline spots being left free. In punctulata and umbrarum the scheme of the colour pattern is still further differentiated by the more specialised character of the spots in certain transverse bands."

"Among Sciomyzines Sc. albocostata, cinerella, fumipennis show a marked striation of the longitudinal veins, leading in the last named species to almost complete vanishing of the ground colour. Spots on the transverse veins are found in griseola amongst others, transverse bars are developed in bifasciella, a median row of spots in the hind marginal cell is characteristic of Schönherri. By bipartition of these spots I should be inclined to explain amongst others the condition of Tetanocera punctata, possessing double rows of spots. The same degree of differentiation has been reached by Sciomyza javana, which in Sc. albocostata is accompanied by a white discoloration of the margins. In this family also therefore, we see several different motives of markings among nearly related forms."

De Meijere therefore, though acknowledging the fundamental equivalency of dark spots on a light ground and light spots on a dark one, does not arrive at the conclusion which I have drawn from the presence of a median bar; on the contrary he considers the two paramedian rows of spots in a cell as derivatives of one median row. A case like Poecilostola, where in one single cell a median row occurs between two lateral ones, and it is exactly this cell which belongs to those internervural spaces that may be supposed to have originated by the coalescence of two neighbouring cells

by obliteration of the separating vein, remains unexplained on DE MEIJERE's hypothesis.

Yet it must be conceded, that it would not be reasonable to assume a coalescence of cells in every case where nervures are accompanied at both sides by rows of light or dark spots, however far the inference, founded on the comparison of Sciomyza to Traginops, seems justified to me, that a dark median bar can be replaced by a light one, and in this way all traces of the original duplicity of the cell can be obliterated. In the case of e.g. Poecilostola such an assumption is out of the question, except for the cells Cu_1—An_2 and An_2—An_1. The same feature is seen in Hepialids among Lepidoptera, which also often show the hourglass- or dumbbell-shaped spots separated into two halves, adjoining opposite nervures, and so forming paramedian rows of independent spots. Black median bars may therefore also be simple remnants of the general dark ground colour.

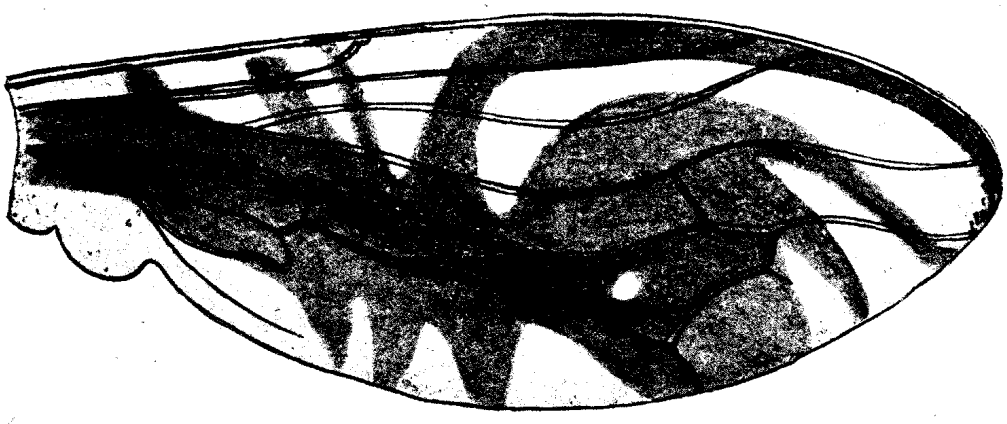

Fig. 7. Cleitamia astrolabei ♀ (Boisd).

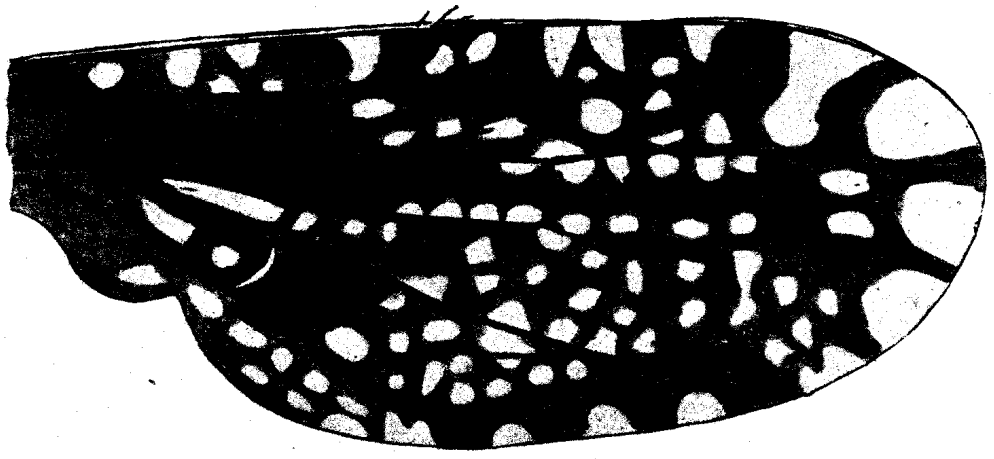

Fig. 8. Trypeta cribrata ♀ (v. d. Wulp).

Should this supposition, as explained in the foregoing, of a regular and simple but complete, original colour-design, common to all Diptera, be true, then it must be possible to bring even the most complicated and variegated patterns occurring in this order, into connection with this fundamental design.

The first test I was able to make in this direction, immediately gave the surprising result, that this comparison proved remarkably easy for a pattern so capricious as that of Cleitamia astrolabei,

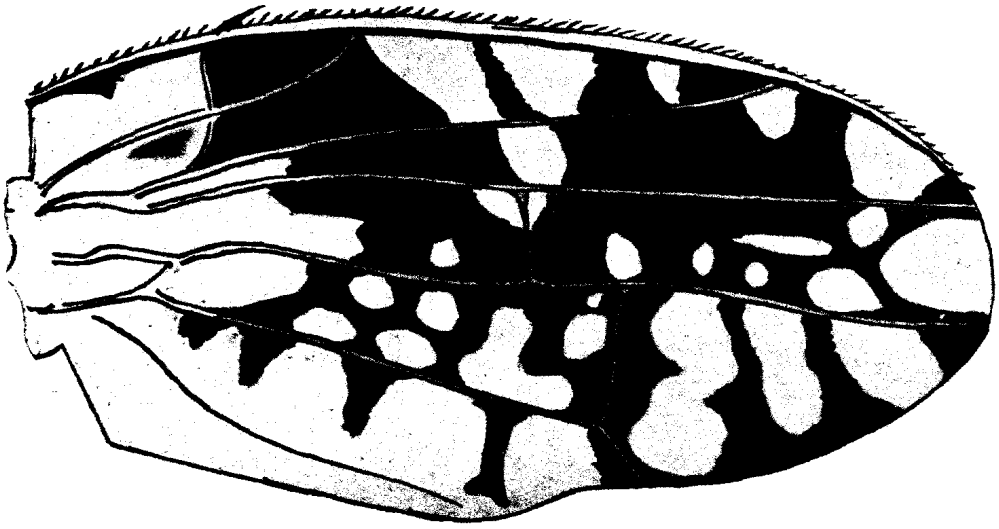

Fig. 9. Tephritis pantherina.

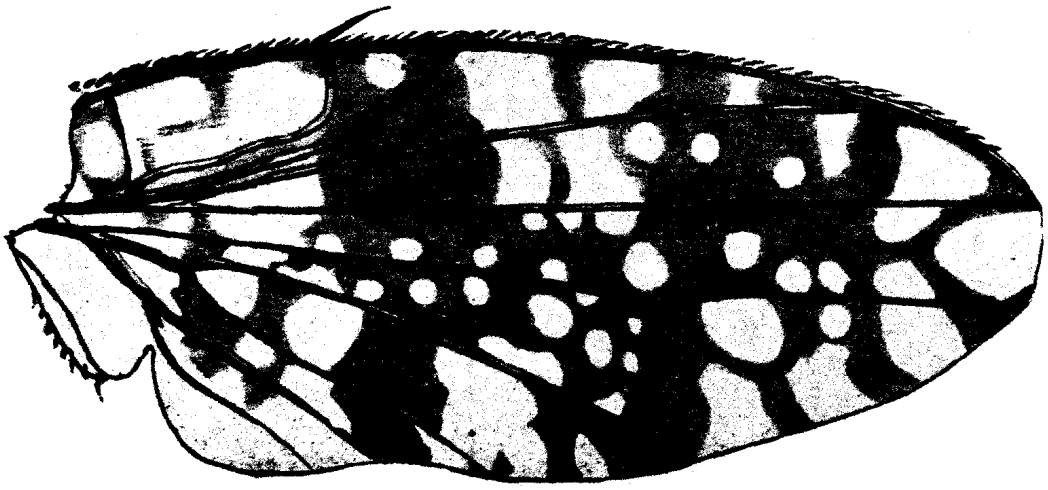

Fig. 10. Tetanocera (Dictya) umbrarum.

consisting of an irregular central dark area, from which ten bars radiate to the circumference in different directions, some of them being straight and short, others long and curved, but all apparently without any regard to the course of the nervures. For comparing this spider-like colour-pattern with that of Tephritis pantherina [which

down to minute details agrees with that of Tetanocera (Dictya) umbrarum and consists in both of a considerable number of light spots on a dark ground, strictly keeping within the limits of the nervures, but often corresponding and fusing in adjoining cells] we become convinced that the lighter areas of Cleitamia exactly correspond in arrangement and size to marginal light spots of Tephritis. The single assumption we have to make is, that along the distal part of the front margin six of these spots have coalesced, and morover have become separated from that margin by a narrow rim of dark pigment, at the same time that a number of spots, especially at the proximal part of the front margin, form connections with more centrally placed ones and so constitute transverse light bars, which extend over the radial nervure. The number of these spots is not absolutely constant, though showing a certain regularity, as becomes evident by the comparison of the wings of Trypeta cribrata with those of Tetanocera umbrarum, showing that spots, which in the latter have coalesced, still remain independent in the former, T. cribrata therefore probably representing a still more primitive state.

As in the case of the species of the genus Haematopota, here also it is possible to arrange a number of nearly related forms in a series, showing a regular transition from the primitive condition: numerous similar light spots in rows on both sides of the nervures, and in certain cells also along the median axis of the internervural space, larger light patches occurring along the wing-margins [e.g. Trypeta cribrata] — then continuing through forms like Tetanocera umbrarum and Tephritis pantherina, in which the number of the spots is diminished, in consequence both of coalescence and of obliteration by pigment-ingression (obscuration) — until we culminate in a form like Cleitamia astrolabei, with its large but less numerous light areas, which differ considerably amongst each other, and do not seem to respect the limits of the nervures.

In the opposite direction Tetanocera umbrarum may be compared in detail (e. g. the number of the spots) with Tetanocera vittigera, on the simple assumption, that the light areas of the former have enlarged to such an extent, that they have coalesced in the middle of the cells and in so doing have cut up the dark background into fragments which in their turn now give the impression of spots. Traces of the original extension of that dark background may still be seen in cell R_5—M_1 and M_1—Cu_1 in the form of faint dark middle-bars.

But besides Cleitamia astrolabei a number of other species of the

same genus occur,[1]) showing a wing-pattern of apparently less complication and capriciousness, which makes them appear simpler and consequently more original. On more exact comparison however, with each other as well as with the patterns in nearly related genera, we become convinced that we should read the series from the other end, starting with astrolabei (or better still with osten sackeni, in which the number of light spots along the front margin is one more than in astrolabei, and so reaches to five) passing along C. biarcuata (Fig. 136), similis (Fig. 134), amabilis (Fig. 128), liturata (Fig. 129), to arrive at kertészi (Fig. 135), whose distal wing-half is almost filled up by a single, broad, dark bar, extending from fore- to hind margin, and only leaving a narrow hyaline halfmoon of white at the wingtip, the proximal wing-half in the mean time not showing an elaborate pattern, but only one dark longitudinal patch in the middle, accompanied along its fore- and hindside by a light streak, and separated from the distal colour-field by a light transverse bar.

As in so many other cases, here also the simplest colour-design is in reality the most modified; it comes nearest to general unicolourism selfcolour).

Starting again from Cl. ostensackeni, we may also go by rivelloides (Fig. 131) and similis (Fig. 132) — while in passing we remark the similarity with the colour-pattern in the genus Bothrometopsa, belonging to the fam. Pterocallinae —, and so come to the species gestroï (Fig. 130), which, though vastly differing in design from kertészi, still exceeds this in extent and uniformity of the dark area.

Besides the observation, that it is possible to find a connection between patterns of widely different appearance, and that one pattern may be derived from the other, a second remark may be made viz. that in different genera, and even in subfamilies and families, the same series of pattern is seen constantly to return, showing the identical interrelation between the different links of the chain. To represent this phenomenon in a marked way, it is desirable to designate the different types of pattern with special names.

For these names the chief motives of the pattern might be used, e. g. that of the paranervural rows of spots (as in Sciomyzas), that of the median series of spots (Scatellas), that of the straight transverse bars (Pterocerines), of the curved bars (Cleitamia astrolabei), of the numerous small spots (Coremacera) etc.

Yet on second thoughts this principle of nomenclature does not

[1]) Compare: Genera Insectorum, Hendel, Platystominae Taf. 7.

seem advisable, as the majority of patterns are composed not only of a chief motive, but at the same time of one or more accessory motives, the latter often representing the remnants of the original design. For instance in the pattern of Cleitamia the light areas between the dark bars may, as argued above, be considered as coalesced light spots, and precisely these spots constitute the original pattern.

Therefore it seems preferable simply to adopt the names of species, genera and families for the patterns which are shown in special clearness and completeness by them, e. g. the astrolabei-pattern, the scatella-design, the Pterocerine-system of bars. It should however never be forgotten, that these patterns (modified in sundry details), may equally well occur in other genera and even families of Diptera, and are also found in other orders of insects, it thus becoming a matter of chance, in what group of insects a characteristic type of pattern is first remarked and named.

As it becomes evident, that between these different types of design a genetic connection really exists, so that they can be arranged in a series, leading from the most primitive and regular to the farthest modified and most capricious, and that this series is the same for different interrelated genera and families, the conclusion, that this correspondence roots in relationship, is a natural one. I accept it in this sense, that the common ancestors of genera and wider groups of interrelated forms already possessed these different patterns, which passed into the hereditary predisposition of their descendants.

In this way the study of Diptera-wings has led me to the same general conclusion, as I was brought to by the intercomparison of Hepialid-wings, "that the motives and patterns of the colour-design are older than the genera and families which display them."

De Meyere has also noticed the phenomenon of the corresponding series of patterns, as is shown by his remark in the opening sentence of his paper: "It is only necessary to look over any tolerably extensive collection of Diptera, to become convinced, that in those families, where coloration occurs, the design may be widely different in the several forms belonging to them, a family-character therefore not being presented, *while on the contrary different families often show the identical patterns*" (the italics are mine).

And again on page 75: "therefore the various motives often return in the different families".

In this feature de Meijere however does not see anything more than a proof, that wing design in different families has developed in similar ways and so should be considered as a case of parallelism.

Of any interrelationship between patterns there could be no question, even within the limits of the same family: "Even where the nervural system is the same, we find either a striation of the transverse nervures or of the longitudinal ones, either a colouration of the wing-root or of the tip. Therefore it would be a mistake to try to arrange the patterns even of one family into one single evolutionary series."

On p. 70 DE MEYERE remarks: "In the group of Trypetines we meet with a number of patterns, which cannot be brought into connection with each other."

It follows from my remarks in the foregoing paper, that I have come to the opposite conclusion.

On p. 63 DE MEYERE calls attention to the fact that: "the broad-winged Trypetine fly Platensina ampla carries some spots which differ from the common hyaline ones in their hue, which seen under a certain angle is dead-brown." The difference, according to his view, is only due to a lighter staining of the chitinous layer and of the hairs arising from it.

By the kindness of my colleague DE MEYERE I was able to investigate a specimen of this fly, and was in the first place impressed by the fact, that these apparently dead spots did not occur over the whole wing-surface, but left the margins free, where, in the usual places also occupied in other fly-species, hyaline spots occurred at regular distances from each other. It furthermore awakened my curiosity, that these central spots, though evidently dead, i.e. not-diaphanous, did not show a brown, but on the contrary a light blue shade, and were slightly lustrous. Noting their position in relation to the hyaline, it became evident, that a bluish spot was situated in the prolongation of each hyaline marginal spot, with the exception of the fifth (adjoining the extremity of the subcostal vein), which was distinguished from the more distal marginal spots by greater length (in a transverse direction) and by a constriction in the middle. This difference might be also expressed by saying that the fifth spot bears a bead-like appendix, by which it extends farther towards the centre of the wing than its companions. It is this appendix which occupies the same position in relation to the peripheral part of the spot, as the blue spots do to the remaining hyaline spots. And furthermore these blue spots occur in exactly the same positions, where in other Trypetines hyaline ones are seen.

I therefore came to the conclusion, that the blue spots are nothing but vanishing hyaline ones, which become obliterated by penetration of the ground colour. Their occurrence is in my opinion a proof for

the assumption, that unicolourism (self colour) is a secondary feature, originating from the effacing of a pattern of spots. Of the way in which this is effected Platensina ampla gives us a good idea.

As remarked above, DE MEIJERE calls the shade of the abnormal spots light brown, when seen in a certain direction, but he leaves undetermined, what direction this is. Now I found, that the colour is very different according to its being observed in reflected or transmitted light. Seen in the latter, the spots are actually brown, but with the first mentioned illumination they are light blue with a hazy lustre. Besides this there is a difference, if the transmitted light is made to pass straight at full strength, or obliquely and in moderate quantity. Only in the latter case the spots stand out clearly against their dark surroundings, showing a light-brown shade, and are clearly seen to transmit more light than the rest of the wing-surface. In strong and directly transmitted light on the contrary they hardly contrast with the surrounding dark wing-membrane, and can only be distinguished from it by a somewhat lighter ring round a darker core. By means of all three methods of observation, however, we may establish the hairs in the area of the blue spots to be colourless, just as above the hyaline spots.

I therefore agree with DE MEIJERE, that the absence of colouring matter in the hairs within the precincts of the dead spots, contributes to their lighter shade, and that this shade furthermore proceeds from a scantier quantity of brown pigment in the wing-membrane. Still I wish to make a distinction between these two causes in so far that I ascribe the whitish-blue lustre of the spots more especially to the first, their hazel-brown shade in weak and obliquely transmitted light on the contrary to the second.

The occurrence of these dead spots therefore provides us with a new argument for asserting that in the order of Diptera the different colour-patterns stand in genetical interrelation, and for opposing DE MEIJERE's inference, that they are absolutely independent of each other.

On p. 70 (at the bottom) DE MEIJERE again mentions a case of two different kinds of spots in a Trypetine fly, viz.: "Tüpfelflecke" in the dark transverse bars, which in several species (especially those related to the genus Tephritis) should be distinguished by shade as well as by localisation from the common hyaline spots situated between these bars, which are considered by DE MEIJERE as remnants of the original unbroken hyaline wing-surface.

The author does not mention the species he means, so that I cannot tell precisely which cases he has in view. But if, as I presume,

he means the brownish tint of part of the light spots, as seen for example in Oxyna parietina, — where a certain number of spots, localised in the broad dark transverse bands, differ from the rest of the spots between these bars in a yellow brown shade as well as in smaller size, — I cannot agree with his distinction of two kinds of spots. For in other species of the genus Oxyna, I see in the same localities similar spots, differing only in so far as they possess the usual hyaline aspect and are not smaller than, or in any other way distinct from their companions in the interspaces between the bars. Therefore I cannot consider the "Tüpfelflecke" themselves as an addition to the pattern, but only their hue and diminutive size as secondarily acquired properties, which, far from leading to the evolution of new spots, on the contrary contribute to the disappearance of existing spots.

Groningen, March 30 1917.

Zoology. — "*On the Setal Pattern of Caterpillars.*" II. By Dr. A. SCHIERBEEK. (Communicated by Prof. J. F. VAN BEMMELEN).

(Communicated in the meeting of March 31, 1917).

In a former communication [1]) I called attention to the constant arrangement of setae on the body of caterpillars, and I gave the reasons which induced me to propose a new nomenclature for these setae, representing them in a set of schematical figures.

My investigations led me to the following conclusions:

1. setae (bristles), tubercula (eminences bearing setae), verrucae (warts), scoli (spines) and maculae (pigment-spots) are all of them homological structures.

2. the abdominal segments possess a setal pattern of more primitive arrangement than the thoracic.

3. the system of bristles which I have designated as type **I** is the most primitive, the remaining types (**I***a*, **I***b*, **II**) may be derived from it.

4. changes occurring in type **I** possess a definite systematic value.

5. stripes have developed at a later date than pigment-spots.

6. the design of the pupa shows the nearest resemblance to that of the first larval instar, but often deviates considerably from that of the last one.

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[1]) A. SCHIERBEEK, *On the Setal Pattern of Caterpillars.* ~~Proc.~~ Verst. Roy. Acad. Sc. Amsterdam. ~~Sect. 2,~~ Vol. XXIV. p. 1710—1723; March 25, 1916.

Proc. 19, 1, 24-38