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PRELIMINARY NOTES ON THE COLOUR PREFERENCES OF
FEMALES *BEMBEX ROSTRATA* (L.) (HYMENOPTERA,
SPHEGIDAE)

A preliminary note

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In the behaviour of animals we may observe, in various circumstances, facts of varying degrees of reaction to different stimuli, preference of certain features to others, of the surrounding world, a kind of hierarchy of impressions received by the animal. This demonstration by the animal of subjective grading of the important features of the surrounding world within the receptive compass of one analyzer in a given situation may be termed a hierarchy of qualities. The term hierarchy of the senses has been proposed to devine the gradation of importance of the senses in their role of informants of the surrounding world; this refers to impressions differing as regards modality (Buddenbrock 1952). These phenomena as a whole were termed the hierarchy of impressions (Chmurzyński 1953).

The animal psychologist encounters the phenomena of the hierarchy of qualities when carrying out experiments of two types. The first of these is experimentation on spontaneous selection. This method was used by, for instance, Ilse (1928) to investigate the hierarchy of colour exhibited by butterflies. The second type of experiment is based on training. Examples can be found in the work of Tinbergen and Kruyt (1938) on the hierarchy of visual qualities exhibited by the females of the *Philanthus triangulum* (F.)

when distinguishing the surroundings of the nest. The method used in this case consisted in training the bee-wolf by means of two groups of land-marks placed round about the nest, and in then placing these marks separately in two situations at each side of the nest. If the wasp chose one of the opposed features, eg. a given visual quality, it flew to the experimental situation differing from the other in that it possessed this feature. By frightening off the insect, it was possible to observe a choice being made between these two situations many times. The ratio of the number of the bee-wolf's flights to both experimental situations was therefore an indicator of the hierarchy of the given qualities with regard to which they differed from one another.

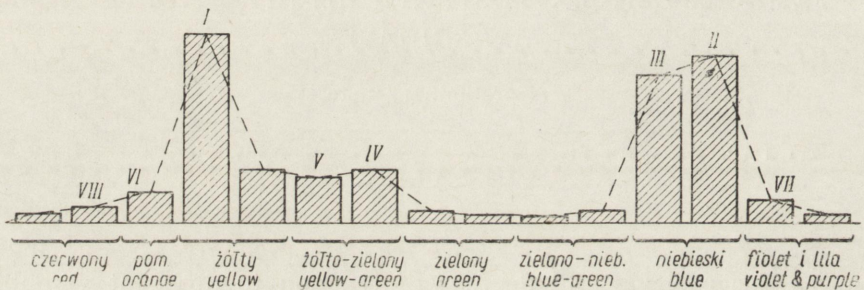


Fig. 1. Diagram sketch of the colour hierarchy of *Vanessa urticae* L. (according to Ilse)*

Szkicowy diagram hierarchii barw *Vanessa urticae* L. (wg Ilse)

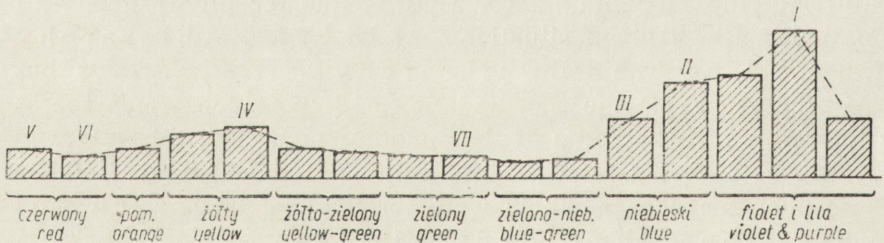


Fig. 2. Diagram sketch of the colour hierarchy of *Gonepteryx rhamni* L. (according to Ilse)

Szkicowy diagram hierarchii barw *Gonepteryx rhamni* L. (wg Ilse)

The hierarchy of qualities (as of the senses), if inherent, is peculiar to all the individuals of a given species of insect, and

* The roman figures indicate the colour order in the hierarchy

constitutes its psychological characteristic in the same way as a given detail of structure constitutes its morphological characteristic, and in both cases the conditioning of the given characteristic can be found. Ilse's investigations (1928) referred to above indicate that the differences in the hierarchy of colour exhibited by the ecological groups of one order of butterflies (the "Vanessa" type hierarchy — fig. 1 and the "Pieridae" type — fig. 2) express their ecological divergences and convergences, and are not dependent on relationships: *Papilio machaon* L. and *Pieridae*, butterflies on the one hand widely divided phylogenetically — on the other hand, they exhibit an identical predilection for violet, blue and purple, colours understandable in relation to the flowers they visit. Butterflies of the "Vanessa" type hierarchy differ from them as regards their environmental and alimentary needs. The colour hierarchy exhibited in butterflies searching for food constitutes their environmental character.

The question arises as to whether insects of a different species with alimentary needs similar to one of the separate groups of butterflies does not exhibit in this respect similarities of colour hierarchy, despite the wider phylogenetic differences than those dividing *Gonepteryx* or *Papilio* from the *Vanessa*, or does it not, in other words, appear that the colour hierarchy exhibited by insects under identical motivational conditions, in the light of their basic disposition to searching for food — is conditioned mainly by ecological factors, and constitutes their environmental character.

This report is the first to be issued on the research carried out in this direction on the females of the *Bembex rostrata* (L.) This insect feeds on purple and blueish-violet flowers, such as the *Thymus serpyllum* L. the *Erodium*, *Knautia*, *Calluna*, and also on yellow flowers such as the *Sedum*, and in this respect is similar to the *Gonepteryx rhamni* L. which alights primarily on heather, as opposed to the *Vanessa urticae* L. which chooses the yellow flowers of the *Hieracium* (Ilse 1928). The training method used in Tinbergen's and Kruyt's work (1938) was applied. Small metal discs painted the following matt colours were used for this purpose: white, black, purple, blue, green, orange, creamy-yellow and red. Polished brass discs supplied the "gold" colour. It should be noted that the colours used in these primitive experiments were to a large extent mixed, and were not of uniform brightness and

depth. This resulted certain shortcomings, eg. it was impossible to establish whether *Bembex* distinguishes spectral red as a separate colour, or sees it only as one of the grey colours category. In spite of this, the experiments carried out made it possible to establish the hierarchical position of the role of these coloured discs in the orientation of the $\overset{\circ}{\circ} \overset{+}{+}$ *Bembex rostrata* (L.) when searching for the surroundings of the nest. This hierarchy would appear to be as follows: purple > blue > creamy-yellow > white > green > gold > black > orange. This may be taken as an approximate picture of the colour hierarchy exhibited when the insect is searching for the surroundings of the nest.

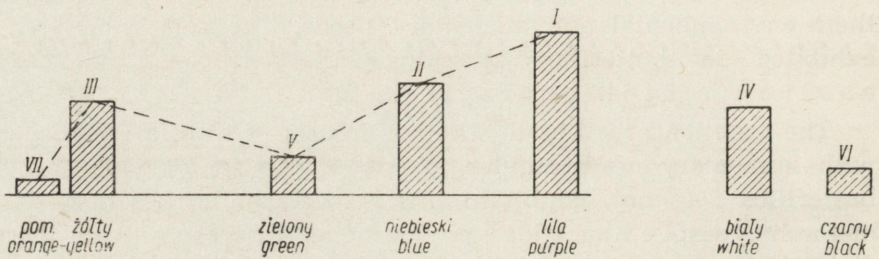


Fig. 3. Diagram sketch of the colour hierarchy of females *Bembex rostrata* (L.) (original)

Szkicowy diagram hierarchii barw samic *Bembex rostrata* (L.) (oryg.)

The similarity of the colour hierarchy of the *hymenopteran Bembex* (fig. 3) to the hierarchy of the "Pieridae" type among butterflies (fig. 2) is striking, and is greater than that between the ecological groups of butterflies described (of course omitting the divergences in the short and long — wave sections, of the spectrum characteristic of the group difference between *Hymenoptera* and butterflies (Kugler 1936, Kühn 1927, Schremmer 1941).

The importance of this similarity should not be over-estimated, however, for the background of the psycho-physiological mood of the butterflies investigated by Ilse (search for food) was different from that of the female *Bembex* investigated (search for their nest). From examples of research on butterflies it is known, however, that the colour hierarchy of the same species may differ in relation to the mood of the insect: eg. with the butterfly of the "Pieridae"

type of colour hierarchy, it is entirely different during the egg-laying period (Ilse 1937) (fig. 4) from that forming a constituent of the alimentary reaction, as we have already seen (fig. 2). Tinbergen, Meeuze, Boerema and Varossieau (1942) demonstrated the similar role of motivational conditions.

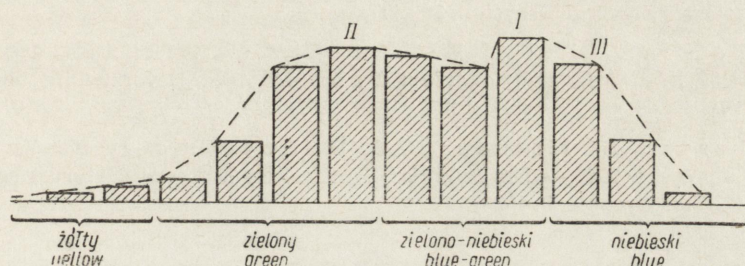


Fig. 4. Diagram sketch of the colour hierarchy of the *Pieris brassicae* L. in relation to its basic disposition to laying eggs (according to Ilse)

Szkicowy diagram hierarchii barw *Pieris brassicae* L. na tle dyspozycji macierzystej składania jaj (wg Ilse)

Colour hierarchy, as is the case of all quality hierarchies, can therefore have a very definite character. It will be possible, however, to establish a real similarity of colour hierarchy between the hymenopteran *Bembex rostrata* (L.) and butterflies of the "Pieridae" type only after research has been carried out on insects in the same psycho-physiological mood of searching for food. It is also intended to use monochromatic colours in further work on this subject.

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WSTĘPNE WYNIKI DOTYCZĄCE PREFERENCJI BARW
U SAMIC *BEMBEX ROSTRATA* (L.) (HYMENOPTERA, SPHEGIDAE)

Doniesienie tymczasowe

Streszczenie

Niniejsza praca miała na celu uzyskanie wstępnych wyników dotyczących hierarchii barw wykazywanej przez samice *Bembex rostrata* (L.).

Hierarchię barw pojmowaną w sensie hierarchii jakości — dawniej hierarchia cech (Chmurzyński 1953) — badano metodą Tinbergena (1938) polegającą na tresurze osy na dwa zespoły znaków optycznych umieszczonych przy norce, a następnie na rozmieszczaniu ich oddzielnie w dwóch układach po jej bokach. Stosunek przylotów owada do obydwu układów doświadczalnych wskazuje na hierarchię danych jakości. W omawianych eksperymentach używano do tresury krążków metalowych, pomalowanych na następujące barwy neutralne i właściwe: białą, czarną, lila, niebieską, zieloną, pomarańczową, kremowożółtą i czerwoną. Były to kolory matowe. Jako barwę „żółtą“ stosowano wypolerowane krążki z mosiądzu. Przy tych wszystkich niedoskonałościach metodycznych przeprowadzone doświadczenia pozwoliły ustalić hierarchiczny szereg roli tych krążków barwnych w orientacji samic *Bembex rostrata* (L.) podczas odnajdywania otoczenia gniazda. Hierarchia ta wydaje się być następująca: lila

> niebieski > kremowożółty > biały > zielony > złoty > czarny > pomarańczowy. Można to w przybliżeniu uznać za obraz hierarchii barw podczas odnajdywania otoczenia gniazda.

Otrzymana w omówionych doświadczeniach hierarchia barw pokrywa się z preferencją do barw kwiatów wykazywaną przez *Bembex* w naturze. To nasuwa możliwość porównania tej hierarchii z analogiczną wykazywaną przez motyle na tle reakcji pokarmowej (Ilse 1928) (fig. 1, 2, 3)*. Z porównania tych szkicowych diagramów nasuwa się wniosek o większym podobieństwie hierarchii barw motyla typu „*Pieridae*“ do błonkówki *Bembex* niż do innego motyla typu „*Vanessa*“ — o innych wymogach środowiskowych.

Obecnie są prowadzone dalsze badania z zastosowaniem tej samej metody, jak również przewiduje się doświadczenia z barwami spektralnymi.

* Cyfry rzymskie wskazują na kolejność barw w hierarchii.