be most complete for that cannabinoid. The acids in figure 2 were obtained in a single gc-ms analysis of oxidation products of CBN. A partially purified culture extract was silylated prior to the gc-ms analysis. CBN-5′-oic acid (**VII**), 3′-hydroxy-CBN-5′-oic acid (**VIII**), CBN-3′-oic acid (**IX**), and the 1′,2′-unsaturated CBN-3′-oic acid (**X**) are the identifiable products, with the CBN-3′-oic acid (**IX**) being the major metabolite. *M. rhodochrous,* therefore, appears to degrade the side chain of CBN by terminal oxidation to a 5′-carboxylic acid, followed by 1 or 2 cycles of the beta-oxidation process. Incubation of CBD with *M. rhodochrous* leads to the formation of CBD-5″-oic acid and CBD-3″-oic acid. Depending on the length of the incubation period and other variables, either the 3″- or the 5″-oic acid may accumulate in greater abundance. The ms fragmentation patterns of the CBD acid metabolites are well defined and very diagnostic for the identification of the acids. The major product formed from the incubation of Δ^8-THC with *M. rhodochrous* is the Δ^8-THC-3′-oic acid, and a small amount of the 1′,2′-unsaturated Δ^8-THC-3′-oic acid is also detectable. Numerous side chain carboxylic acid metabolites of cannabinoids have also been identified in mammalian systems, in which the odd-numbered 1′-,3′- and 5′-oic acids are the most common[8-11]. In addition, other workers have reported the production of carboxylic acid side chain degradation products of the synthetic cannabinoid nabilone by the bacterium *Nocardia salmonicolor*[12].

In conclusion, we have identified 2 different microorganisms which are capable of partially degrading the cannabinoid pentyl side chain by removing the 2 terminal carbons. *M. rhodochrous* gives the same type of products as are obtained in the animal systems which are known to oxidize the side chain to form carboxylic acids. *S. racemosum* acts upon the pentyl side chain by a subterminal oxidation process. It is likely that both organisms metabolize the cannabinoid side chain as if it were the terminus of a long straight chain hydrocarbon.

1 Acknowledgment. The authors wish to express their gratitude to Dr E.H. Fairchild for pmr and mass spectra, Dr R.L. Foltz for gc-ms analysis and to the National Institute on Drug Abuse for financial assistance in the form of a research grant.
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Dominance and hierarchy in *Polistes gallicus* colonies attained through photoelectric properties

B. Perna, N. Croitoru[1] and J. S. Ishay

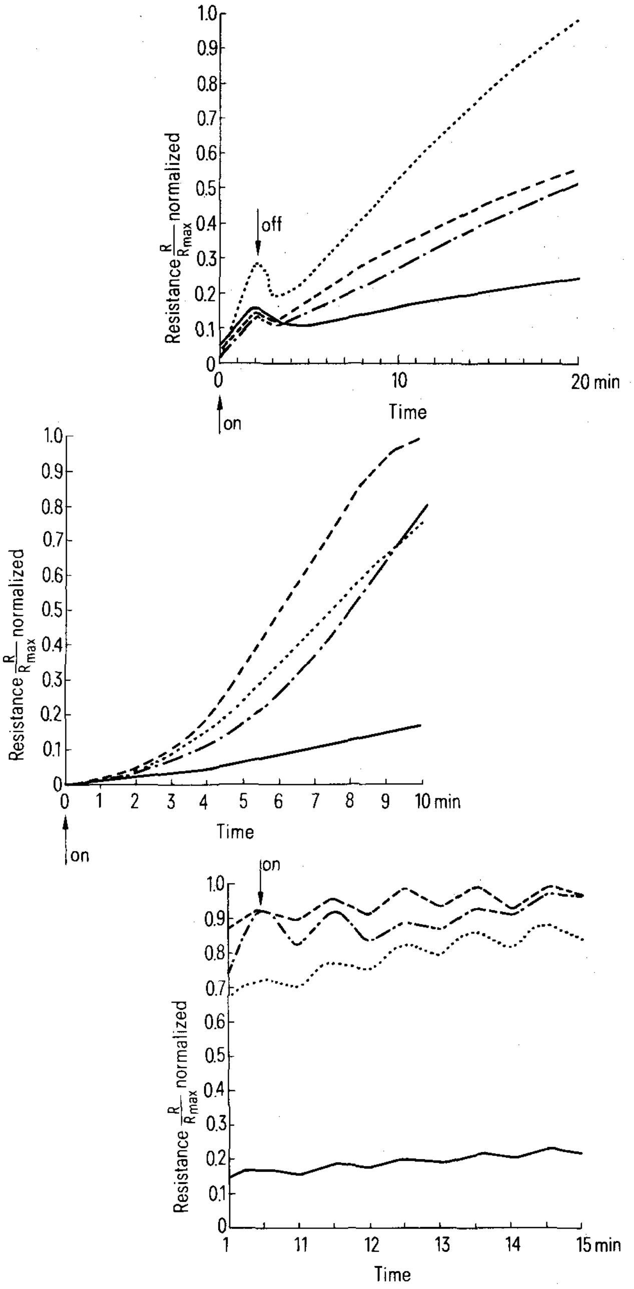
Department of Physiology and Pharmacology, Sackler School of Medicine, Tel Aviv University, Tel Aviv (Israel), 29 December 1977

Summary. There is a clear difference between the photoconductive properties of the workers and the females in *Polistes gallicus* wasp colonies. It is suggested that the dominance order in these colonies is based also on their photoconductive properties, which may have organizational and orientational values.

A dominance system has been shown to exist among females of the paper wasp *Polistes gallicus,* so that when 2 or more females found a nest in the spring, one comes to function as the egg layer, while the others assume a subordinate role[2,3]. Pardi[4,5] discovered that the dominant, fecund female establishes her position and controls the other females by direct aggressive behaviour.

Suspecting that the dominance and hierarchy among the females of a *Polistes* colony might have some organic basis, we decided to study the photoelectric properties of the cuticle of various wasps. In previous papers[6,7], we reported that the yellow strips on the gaster and frons of hornet workers *(Vespa orientalis)* are photoconductive. This photoconductive phenomenon occurred following preliminary irradiation of the workers with the light. The present paper describes attempts to measure the photoelectric properties of various members of several *Polistes gallicus* colonies in order to ascertain whether possible differences in the properties of their cuticle might determine the hierarchy of females (i.e. the dominance of the so-called α-females over the subordinate β-, γ-, ... ω-females), and the differences between the α-female and the workers in the colony.

2 series of experiments were performed to determine 2 points: a) the change in the cuticular resistance under short (2 min) illumination followed by 20 min darkness; b) the change in resistance under prolonged illumination (10 min) followed by a period of alternating light-darkness (30-30 sec of each). The test insects were females (α, β, and γ) and workers from 7 polygynous colonies of *P. gallicus* collected from Mosciano (Florence), Italy. The order dominance in the colonies was observed during the active season in the Department of Zoology of Florence University. Our measurements pertained to the abdominal segments only. The resistance was measured with a Keithley Digital Electrometer Model 616, having a sensitivity in the range of 10^5 to 10^{12} Ohm. Hookup of the cuticle strips to the electrometer was accomplished with a tungsten wire, 0.05-0.1 mm in diameter, both ends of which were smeared with a small amount of colloidal silver paint. The source of light was a microscope incandescent white light bulb, 100 W and 24 V.



The results of brief (top), prolonged (middle) and alternating (bottom) irradiation with light on the yellow strips of *P. gallicus* α-female in comparison with 3 of her workers. The data are based on measurements on members of one single colony. Each value is a mean of 3 determinations after removal of the nest from its natural habitat. All data was transformed to logarithms (natural) and the analysis performed. The differences in resistance between the α-female and workers 1 and 2 are not significant after 2 min of illumination (top figure), while those between the α-female and worker 3 are significant ($p < 0.005$). The differences in resistance between the α-female and the 3 workers are significant in the dark period, i.e. starting from min 3 after switching off the light. During the prolonged illumination (middle) the differences in resistance between the α-female and the 3 workers are significant after min 3 ($p < 0.05$) and the differences in resistance grows continuously. The 3 workers generally show a similar pattern. During the alternating period (bottom), the differences in resistance are significant between the 3 workers and the α-female ($p < 0.0005$). The workers show a similar pattern among themselves during this period. In the other colonies, measured in the same way, we observed different resistance values, but in all cases the results were generally proportional.

Some of our findings are presented in the figure. As can be seen, brief illumination (top picture) results in a distinct difference in cuticular resistance between the α-female and the 3 workers in her nest. (The workers were numbered according to their ages, i.e. worker No. 1 is the oldest.) The α-female being less sensitive to illumination (after 2 min of light, the differences in resistance between the female and the workers are significant). The workers generally show an increase of the cuticular resistance which does not return to the initial level after switching off the light. There is also a significant difference between workers No. 1 and 2 and worker No. 3, although all 3 display the same pattern. The variation in resistance is followed by more rapid relaxation after illumination. Compared to α-female, the workers have a slower relaxation and the resistance attained after illumination is higher than the starting level. β- and γ-females were also measured, but they hardly showed any changes in resistance after illumination.

Differences are also evident in the prolonged illumination experiments (10 min illumination, middle picture). From the results obtained one can see that the yellow strips of the workers undergo a very high elevation of resistance, i.e. the resistance grows faster and higher than that of the α-female, reaching a saturation value. The subordinate females invariably had a significantly lower level of increased resistance than the α-female and they never attained a saturation value. As for the α-female, although she attained a saturation value, she usually required more than 10 min of illumination to do so.

During the alternating light-darkness period (lower picture) (30 sec light - 30 sec darkness) a photoconductive effect was clearly evident in the workers, i.e. the resistance decreased during the light phase and increased during the dark phase. Apart from the first min of the alternating period, which corresponded to 11 min of the prolonged illumination phase, there was no significant difference between the 3 workers in the pattern of the resistance. However, there was a significant difference in resistance between the workers and the α-female. The average difference in amplitude between the dark period (high resistance) and the light period (low resistance) was about 10% for the workers and less than 2% for the α-female. The β- and γ-females did not display any change in amplitude during the light-darkness treatment, i.e. they practically did not show any photoconductive properties.

The same experiments were run on the brown strips in various parts of the wasp's cuticle, but these failed to show any photoconductive properties. Rather, the resistance of the brown strips increased continuously during the light and dark periods, after the initial illumination, much as in the case of the yellow strips of the subordinate females.

The above findings suggest that: a) there is a clear photoconductive difference between the workers as a group (caste) and the females, especially between them and the α-female; and b) there is a difference between the α-female and the subordinate females in that the α-female still preserves the photoconductive effect whereas the others have apparently lost it. These results constitute additional evidence for caste differentiation within colonies of these social wasps.

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