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RAPID COMMUNICATION

INFLUENCE OF AGE ON THE FLUCTUATION OF IRON IN THE OENOCYTES OF HONEY BEE (*APIS MELLIFERA*) DRONES

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SUMMARY

Since the discovery of magnetite in biological organisms including honey bees, localization in the organism and specific functions have been sought. Groups of cells (oenocytes) located in the abdomen of honey bee workers and queens have been found to contain iron-rich granules. Now, for the first time, these granules are reported in honey bee drones, but the concentration appears to be age-related. Oenocytes of drones only 0- and 3-days old did not stain positively for iron, while those of 6-, 9- and 12-days did. A function relating the accumulation of iron with maturation, drone flight directionality, and the establishment of drone congregation areas is hypothesized.

INTRODUCTION

The apparent sole function of drones in a honey bee colony is to mate with virgin queens, an activity that first requires about 2 days of maturation (presumably physiological as well as sexual) after emergence (RUTTNER, 1966). Mating flights also require flight directionality since drones are known to collect in specific drone congregation areas (DCA's) independent of the presence of a queen generally 10 to 25 meters above ground and as far as 6-7 kilometers from the colony (KONAPACKA, 1969 ; RUTTNER, 1966). It is not known how either the queens or drones locate these areas day-after-day (GERIG, 1972) although pheromones may play a supporting role (GARY, 1962 ; RUTTNER, 1966). It has been proposed that drones may orient by means of physical features of the landscape. RUTTNER (1966) and VAN PRAAGH (1975) reported a uniformity of the angular radiance distribution in DCA's that was unique relative to nearby areas outside the DCA.

The presence of iron deposits with magnetic properties has been reported in honey bee queens and workers (GOULD *et al.*, 1978 ; GOULD, 1980). To my knowledge, no reference to such inclusions occurring in honey bee drones exists in the literature, although Dr. Joe KIRSCHVINK of California Institute of Technology, Pasadena, CA (pers. comm.) has found magnetic remanence in workers and drones. Up to the present, no one has presented any data ascribing any biological function to these deposits although GOULD and KIRSCHVINK hypothesized that magnetite in drones may assist them in finding DCA's (pers. comm.). In worker bees, a magnetic component in the recruiting « waggle » dance has been demonstrated (LINDAUER and MARTIN, 1968). KUTERBACH *et al.* (1982) have suggested that the magnetic response in worker honey bees is localized in bands of cells (oenocytes) around each abdominal segment since they have shown that these cells contain iron as visualized using the Prussian blue stain. The purpose of this study was to determine whether drone oenocytes of all ages contained iron.

MATERIALS AND METHODS

One full-depth Langstroth frame with sealed drone comb was incubated at 33 °C. When at least 150 drones emerged in an 18 hr period, these were transferred to a screen cage and placed in a normal colony where the drones could be fed and allowed to mature. On the first day (day « 0 »), and on days 3, 6, 9, and 12, ten drones were removed, decapitated, the abdomens slit, and placed in 4 % neutral, buffered formalin. After 2 days of fixing, the abdomens were opened and stained with Prussian blue (KUTERBACH *et al.*, 1982).

RESULTS AND DISCUSSION

Although the oenocytes were visible in all drones, stained granules were seen in older drones but not in the 0- and 3-days old drones (n = 10 for each day). These results indicate an age-related accumulation of iron related to maturity and/or possibly to biological functionality. It is necessary to perform additional age-related studies with more sophisticated techniques and to determine if these iron deposits play a role, either in drone flight orientation or some other biologically significant function. It should be noted that the mineral content of worker honey bees increases with age up to day 6, and then stabilizes at a slightly lower level (DIETZ, 1971). Additionally, the levels of P, K, Ca, Mg, and Na generally increased to 150-200 % above the day « 0 » levels and iron increased about 460 % above the day « 0 » levels. Young drones (0- to 3-days old), besides being sexually immature, may be incapable of directional flight until sufficient iron has

been accumulated in the oenocyte cells and converted biologically to magnetite. Recently, KIRSCHVINK and co-workers presented a paper at the meeting of the American Geophysical Union [reported by WEISBURD (1984)] in *Science News* describing a correlation between the orientation of whales and magnetic anomalies suggesting that whales use magnetic highs « as a kind of anchor point ».

I hypothesize that honey bee drones may be using a combination of cues including magnetic sensitivity to locate drone congregation areas.

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RÉSUMÉ

INFLUENCE DE L'AGE SUR LA TENEUR EN FER DES ŒNOCYTES DES MALES D'ABEILLE (*APIS MELLIFICA* L.)

Depuis la découverte de la magnétite dans les organismes vivants, dont l'abeille, on a recherché sa localisation dans l'organisme et ses fonctions spécifiques. On a montré que des groupes de cellules (les œnocytes) situées dans l'abdomen des ouvrières et des reines d'abeilles contenaient des granules riches en fer. On signale aujourd'hui, pour la première fois, la présence de ces granules chez les mâles, mais leur concentration semble liée à l'âge. Les œnocytes des mâles âgés de 0 à 3 jours ne montrent aucune coloration liée au fer, contrairement à ceux des mâles âgés de 6, 9 et 12 jours. On propose une hypothèse, selon laquelle la concentration en fer au cours de la maturation est liée au maintien de la direction de vol et à la formation de lieux de rassemblement de mâles.

ZUSAMMENFASSUNG

DER EINFLUSS DES ALTERS AUF DEN EISENGEHALT DER OENOZYTEN VON HONIGBIENEN

Seit der Entdeckung von Magnetit in Organismen, einschließlich der Honigbienen, hat man nach seiner Lokalisierung im Organismus und nach seiner Funktion gesucht. Es wurde festgestellt, daß Zellgruppen (Oenozyten) im Abdomen von Arbeitsbienen und Königinnen eisenreiche Granula enthalten. Jetzt wird zum ersten Mal über solche Granula bei Drohnen berichtet, aber ihre Konzentration ist offensichtlich altersabhängig. Die Oenozyten von 0- bis 3-tägigen Drohnen zeigten keine positive Eisenfärbung, Drohnen von 6, 9 und 12 Tagen Alter hingegen schon. Es wird die Hypothese aufgestellt, daß die Anreicherung mit Eisen während des Reifungsprozesses mit der Einhaltung der Richtung während des Drohnenfluges und mit der Entstehung von Drohnensammelplätzen in Zusammenhang stehen könnte.

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