Résumé. Le taux des catécholamines du myocarde a été dosé chez le rat sauvage vivant dans la nature et chez le rat de la même espèce vivant dans des conditions de confinement en laboratoire. Chez l'animal élevé en laboratoire le taux des catécholamines est significativement plus élevé que chez son homologue vivant dans la nature.

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Thermoregulatory Pheromones in Wasps

Wasps and hornets (family Vespinae) are widespread throughout the Northern Hemisphere. The more familiar social species belong to the subfamily Vespinae[1,2]. Thermal measurements taken within the nests of various species have shown that the temperature is maintained at quite a constant level[3-6]. This work has been done to understand how the temperature regulation is maintained.

Material. Temperature and thermoregulation were studied using groups of adults or single pupae and larvae of the following species: *Vespa orientalis* (VO), *V. crabro* (VC), *Paravespula germanica* (PG), *P. vulgaris* (PV), *Dolichovespula saxonica* (DS), and *D. media* (DM).

Methods. Groups of 50–200 wasps or hornets were kept at room temperature (18–25 °C) with and without brood combs within boxes having glass coverts to enable observation. Temperature of wasp clusters or single pupae or larvae was measured with a platinum thermoelement (5 mm × 3 mm, Degussa, Hanau) and recorded with a Punktschreiber (Hartmann and Braun). Observations were made on the behaviour of wasps in clusters as well as toward brood combs, pupae and larvae which were removed from the combs. Various stages of wasps and several other species of insects, social and non-social were extracted either in tap water, acetone aether or 70% ethyl alcohol. Strips of filter paper impregnated with the above extracts, freeze dried as well as wax or plastic replicas of pupae have been examined for their thermoregulatory triggering effect on wasps. Pupae were incubated in thermostat at 20 °C and 32 °C (60–70% humidity) in order to study the influence of the temperature on their maturation.

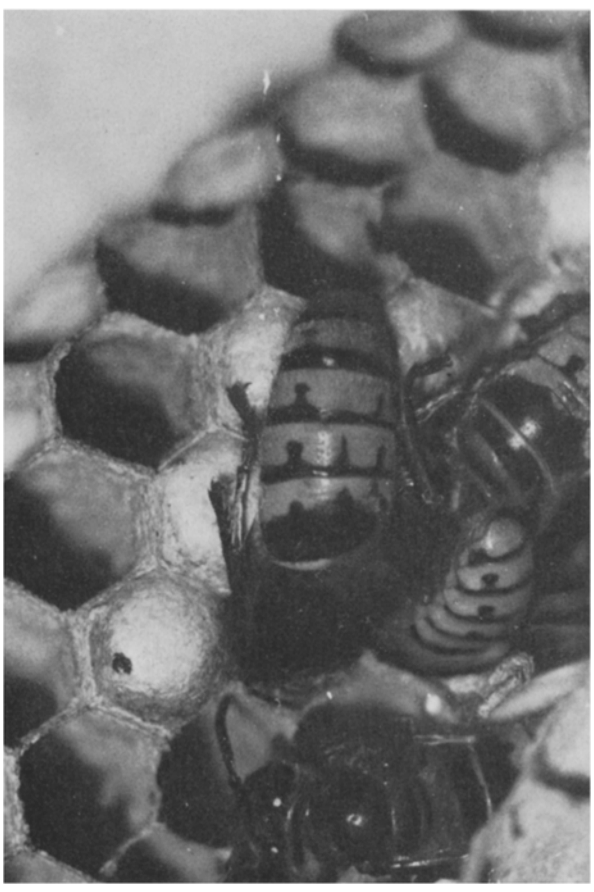

Fig. 1. Workers of *Vespa crabro* on the comb in the usual position when warming pupae. Photo: Mr. U. Eidam.

Results. Groups of wasps, PG, PV, DS and DM, tend to congregate in tight, multilayered culsters in the lower corner of the box. Once they form a cluster, the wasps start rapid abdonimal pumping movements by alternatively retracting and extending the abdominal segments at a rate of up to 180 movements per minute. Hornets, VO and VC form a single-layered cluster in the uppermost part of the box and just like the wasps, exhibit constant abdominal pumping movements. The temperature reading amidst the wasps was usually 29–35 °C as compared to 23–25 °C measured within the box.

Wasps or hornets which were offered a comb belonging to their own species and containing brood (i.e. eggs, larvae and pupae) in the normal position (cell opening downwards), rapidly occupy the comb, some of the workers enter vacant cells adjacent to a pupa, place their abdomen against the cocoon and commence the abdominal pumping movements (Figure 1). Within 5–7 min they raise the temperature of the pupa to 30–32 °C as compared to 20–22 °C outside the comb. In no instance were workers observed to warm the larvae or the eggs. Temperature readings on unwarmed individual pupae, intact within their cocoon, do not differ from that of the immediate environment. In contrast, the temperature of unwarmed individual larvae slightly exceeds (by 2–3 °C) the environmental temperature (Figure 2). When pupae are removed from their cocoons through the upper surface of the comb (so as not to damage the silk dome), the workers will cease warming the empty cocoons. If a pupa is removed from its cocoon and placed in the midst of a group of wasps

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[3] H. Himmer, Z. vergl. Physiol. *5*, 375 (1927).
[4] A. Steiner, Beih. schweiz. Bienenztg. *2*, 139 (1947).
[5] J. Ishay, H. Bytinski-Salz and A. Shulav, Israel J. Ent. *2*, 45 (1967).
[6] J. Ishay und F. Ruttner, Z. vergl. Physiol. *72*, 423 (1971).

deprived of brood combs, the adults will approach the pupa, circle it, and start licking off its old pupae cuticle. This accomplished, they will lie alongside the pupa and initiate abdominal pumping, soon raising the temperature of the pupa to 29–35 °C. The closer the pupa to maturation, the more preferential the thermoregulatory treatment it receives.

The wasps PG, PV, DS and DM, apart from warming their own or the reciprocal pupae, will also warm pupae of VC, but not of VO. As for adults of the latter 2 hornet species, they will only warm pupae of their own species. The following may serve as a typical example of such reciprocal warming: a pupa of VC is presented to a group of imagines of PV. Soon, 8 to 15 adult wasps of this rather diminutive species arrange themselves around the much larger pupa, and start warming it, raising its temperature after 30–40 min to 29–33 °C as compared to a surrounding temperature of 23 °C. (Figure 3). The workers continue to warm the pupa for days, up to the maturation of the imago. From this point on, however, their behaviour

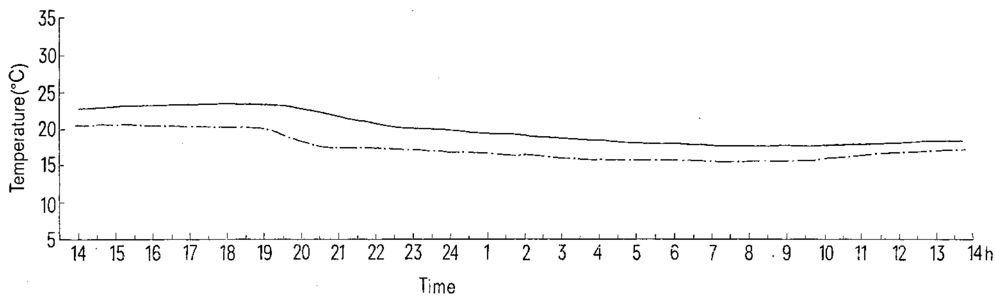

Fig. 2. Temperature recording of a larva of *V. crabro* (top plot). The larva is situated in the normal position within its cell. The thermoelement is interposed between the cell wall and the body of the larva.

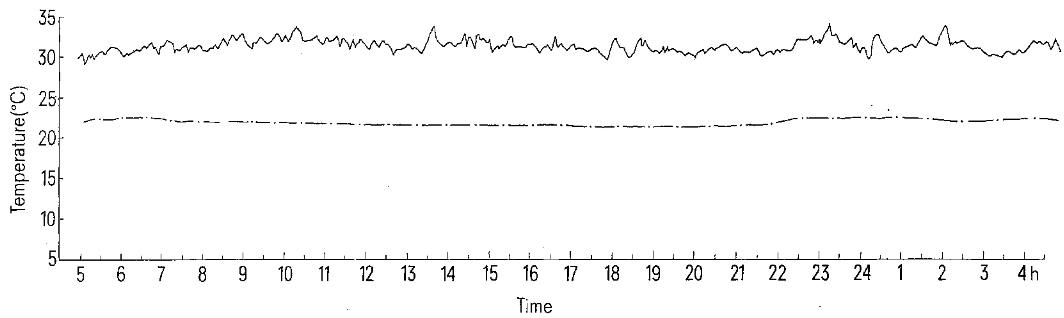

Fig. 3. Temperature recording of a pupa of *V. crabro* (top plot), which is being heated by workers of *Paravespula vulgaris*. The thermoelement is attached to the pupa.

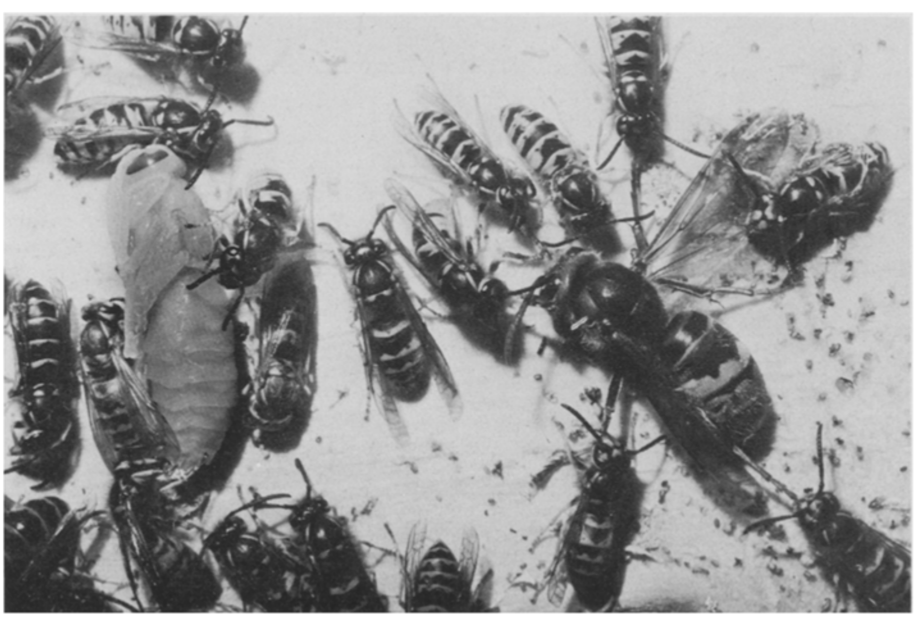

Fig. 4. Wasp workers (*P. vulgaris*) heating hornet pupa (*V. crabro*) while their companions attack an adult hornet, gripping its extremities. Photo: Dr. U. MASCHWITZ.

becomes hostile. Some of them now grasp the newly formed imago by its antennae, legs, wings and sting, while others proceed to sting it to death, much as they would do to any intruder in the nest (Figure 4). Wasps have never been observed to warm pupae of honeybees (inside or outside their cells), of ants or other insects at different stages, nor their own freeze dried or dummy pupae. Wasp pupae that had been cut in two or frozen to death, pupae kept in total darkness or wrapped in filter paper, do elicit heating behaviour. Filter paper strips impregnated with alcohol extracts of pupae alone, release the thermoregulatory behaviour: wasps cluster around the strip and proceed to heat it, for a short duration by typical abdominal pumping movements (Figure 5). Pupae incubated at 32°C undergo metamorphosis to visible perfect adults, with fully-formed wings, those incubated at 22°C or at room temperature grow to be mostly malformed, in the majority of cases with undeveloped (or wet) wings.

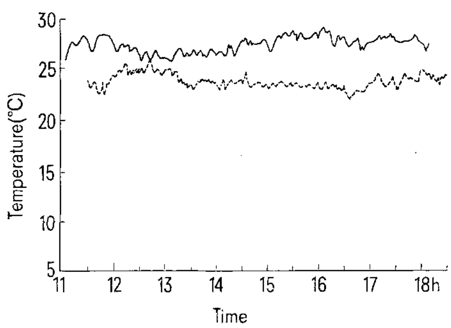

Fig. 5. Temperature recording (top plot) from a strip of filter paper heated by *Dolichovespula media* wasps, as compared to the surrounding temperature (bottom plot). The filter paper was impregnated with alcoholic extract of dark pupae of the same species.

Discussion. The results suggest that the volatile emanation of the pupae and not their color, shape or size, are responsible for the adults response and that the abdominal pumping movements of imagines near their pupae are triggered by pupal pheromone(s). The different intensity and duration of heating elicit by pupae proper, or their alcoholic extract, would seem to suggest a feedback mechanism, the pupa continuously stimulating the adult wasp to ventilatory movements. There can be little doubt that under the ecological conditions in which wasps develop, the active warming by the imagines of the stationary pupae contributes significantly to their successful maturation. However, I have not yet established whether the pupae of each species of wasps has its own pheronome to induce thermoregulatory behaviour, or whether the pupae of different species possess identical pheromone(s) which disappear(s) in the adult stage. The mechanism triggering thermoregulatory behaviour of adult wasps in clusters awaits also further elucidation[7].

Zusammenfassung. Beobachtung, dass Wespen und Hornissen auch nach deren Entnahme aus den Waben ihre Puppen erwärmen, da sie sich sonst zu verkrüppelten Imagines entwickeln. Die von den Puppen ausgeschiedenen volatilen Substanzen (Pheromone) fördern das Brüten der Arbeitswespen, was beweist, dass es sich um ein thermoregulatorisches Pheromon handelt.

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17 April 1972.

[7] This research has been done in the Institut für Bienenkunde, Oberursel/Ts., Department of Zoology, Frankfurt University, and supported by a grant from the Deutscher Akademischer Austauschdienst.

Suppression of Pup Retrieving Behavior in Rats Following Administration of L-Δ^9-Tetrahydrocannabinol

The behavioral effects of marihuana and its derivatives are currently the subject of intense experimental investigation. The present study extends these efforts to an examination of the effects of L-Δ^9-tetrahydrocannabinol(Δ^9-THC), the principal active component in marihuana, on maternal behavior in the rat.

Materials and methods. The subjects were 9 adult female rats, individually housed in cages 41 cm × 17.5 cm × 24 cm. The females arrived pregnant in the laboratory one week prior to parturition. After parturition, each litter was culled to 5 pups per dam.

Test conditions were similar to those described by Whalen[1]. Shortly before birth, shredded pieces of paper were placed in the home cages for the females to make nests with. Subjects were tested on days 7 and 10 after parturition. On day 7, the females were removed from their cages into which two wooden partitions were then inserted, thus dividing the cages into three equal sized sections. Each partition contained an opening of 10 cm through which the female could easily pass. In addition, each partition contained several holes of 2 cm in diameter. Immediately after i.m. injection of either 10.0 or 20.0 mg/kg Δ^9-THC in Triton X-100, or Triton X-100 only, in case of control animals, the females were returned to their litters. 2 h later, the females were again taken from their cages. During the following min, the pups were removed from the nest and were placed in the far end of the cage. The females were then returned to the area of the nest and were kept there for 1 min by blocking the opening in the partition. The obstruction was then removed and observations were made as to the latency for the female to enter the area into which the pups had been placed as well as the time taken to return all 5 pups to the nest. A limit of 5 min was imposed on the test period. On day 10, these treatments and observations were repeated with the exception that females previously receiving drug, now received placebo injections while previous placebo subjects now received 10.0 mg/kg Δ^9-THC. During the experiment, if a female failed to retrieve any pups during the test period, it was retested for an additional 5 min a few min later. If females retrieved during this second test session, the previous results for that animal were disregarded. Differences between groups were evaluated using the Kruskal-Wallis 'H' and the Mann-Whitney 'U' statistics[2].

[1] R. E. Whalen, in *Animal Behavior in Laboratory and Field* (Ed. A. W. Stokes; Freeman and Co., San Francisco 1968).

[2] S. Siegel, *Nonparametric Statistics* (McGraw Hill, New York 1956).