A more detailed look at the Asian hornet *Vespa velutina* (Hymenoptera: Vespidae)

Michel Asperges, †Wim Tollenaers & Zoë Vanstraelen

Abstract. We tried to gain more insight into the morphology (external characteristics) of the wasp *Vespa velutina* Lepeletier, 1836 (Hymenoptera: Vespidae) and, where possible, to find a connection between structure and function. We studied the different morphological parts of the wasp: i) the head part with the antennae and the smell and fragrance plates; ii) the mouthparts with the jaws and the lower lip with flavour nodules; iii) the thorax part with the wings and legs and their different parts; iv) the abdomen with the sting.

Samenvatting. We hebben getracht met het onderzoek een beter inzicht te krijgen in de morfologie (anatomische delen) en waar mogelijk een verband te vinden tussen de delen en het functioneren van de wesp *Vespa velutina* Lepeletier, 1836 (Hymenoptera: Vespidae). We bestudeerden de verschillende morfologische delen van de wesp: i) het kopgedeelte met de voelsprieten met de reuk- en geurplaten; ii) de monddelen met de kaken en de onderlip met smaakknobbels; iii) het borstdeel met de vleugels en de poten met hun verschillende delen; iv) het achterlijf met de angel.

Résumé. Nous avons essayé de mieux comprendre la morphologie (caractéristiques externes) de la guêpe *Vespa velutina* Lepeletier, 1836 (Hymenoptera : Vespidae) et, si possible, de trouver un lien entre la structure et la fonction. Nous avons étudié les différentes parties morphologiques de la guêpe : i) la tête et les antennes avec les plaques odorantes et parfumées ; ii) la partie buccale avec les mâchoires et la lèvre inférieure avec les nodules aromatiques ; iii) la partie du thorax avec les ailes et les pattes avec leurs différentes parties; iv) l'abdomen avec le dard.

Key words: Asian hornet — Morphology.

Asperges M.: Universiteit Hasselt, Faculteit Wetenschappen, BE-3590 Diepenbeek, Belgium. michel.asperges@uhasselt.be

†Wim Tollenaers, director of the Lieteberg visitors' centre in Zutendaal, passed away at the age of 34 on October 18, 2022.

Vanstraelen Z.: De Lieteberg vzw, Zuurbroekstraat 16, BE-3690 Zutendaal, Belgium. zoe@lieteberg.be

DOI: 10.6084/m9.figshare.23803419

Introduction

The Asian hornet *Vespa velutina* Lepeletier, 1836 (Hymenoptera: Vespidae) shows many similarities with the honeybee and other bees; it is also a sting-bearer (Aculeata) like honeybees, bumblebees, solitary bees, and ants. This wasp belongs to the Pleated Wing Wasps (see also the wings). According to Schoonvaere (2020), the species was first observed in Europe in the French department of Lot-et-Garonne in 2005 and in Belgium in 2017 by Desmadryl in Poperinge. Between 2005 and 2012, the hornet spread very rapidly. French researchers suspect that fertilized queens of the Asian hornet (*Vespa velutina* var. *nigrithorax* du Buysson, 1905), with their dark to black-brown thorax, arrived in 2004, as 'stowaways' on an Asian ship carrying ceramic merchandise. According to de Wilde & Haxaire (2011), a steady expansion of this alien species has been observed in the Bordeaux region since 2006. In 2009, there were already at least 1100 nests. Since then, they can now also be found regularly in Belgium throughout all the provinces.

The Asian hornet is an insect, with a head, thorax, abdomen, three pairs of legs, and two pairs of wings (Fig. 2). These wasps are active hunters. Their favourite food is the muscle, among the other things present in the thorax of bees. Towards the end of the summer, sweet fruits are also on the menu. Prey is awaited by the hornet while flying. As soon as a bee starts foraging and leaves the hive's flying board, it is grabbed by the hornet. Rarely does the hornet catch bees on the flying board; if it were to do so, the honeybees would defend the entrance to the colony and kill the hornet. Hornets are therefore very harmful to honeybees; they are hardly aggressive to humans except in the vicinity of the nest. They are very attentive around their own nest, especially around their first paper spring (Fig. 1) and summer nest, which is constructed quite low in a tree or shrub. In the second, much larger, paper nest, which they usually make very high in a tree, the young queens are born and fertilized for the following year. It is therefore especially important to destroy this nest. Should you find a nest, ask the fire brigade to destroy it. Never attempt to destroy a nest yourself; this requires a specialized approach (protective clothing and poison).

Fig. 1. Open the first spring paper nest. © Michel Asperges.

 ISSN 0771-5277

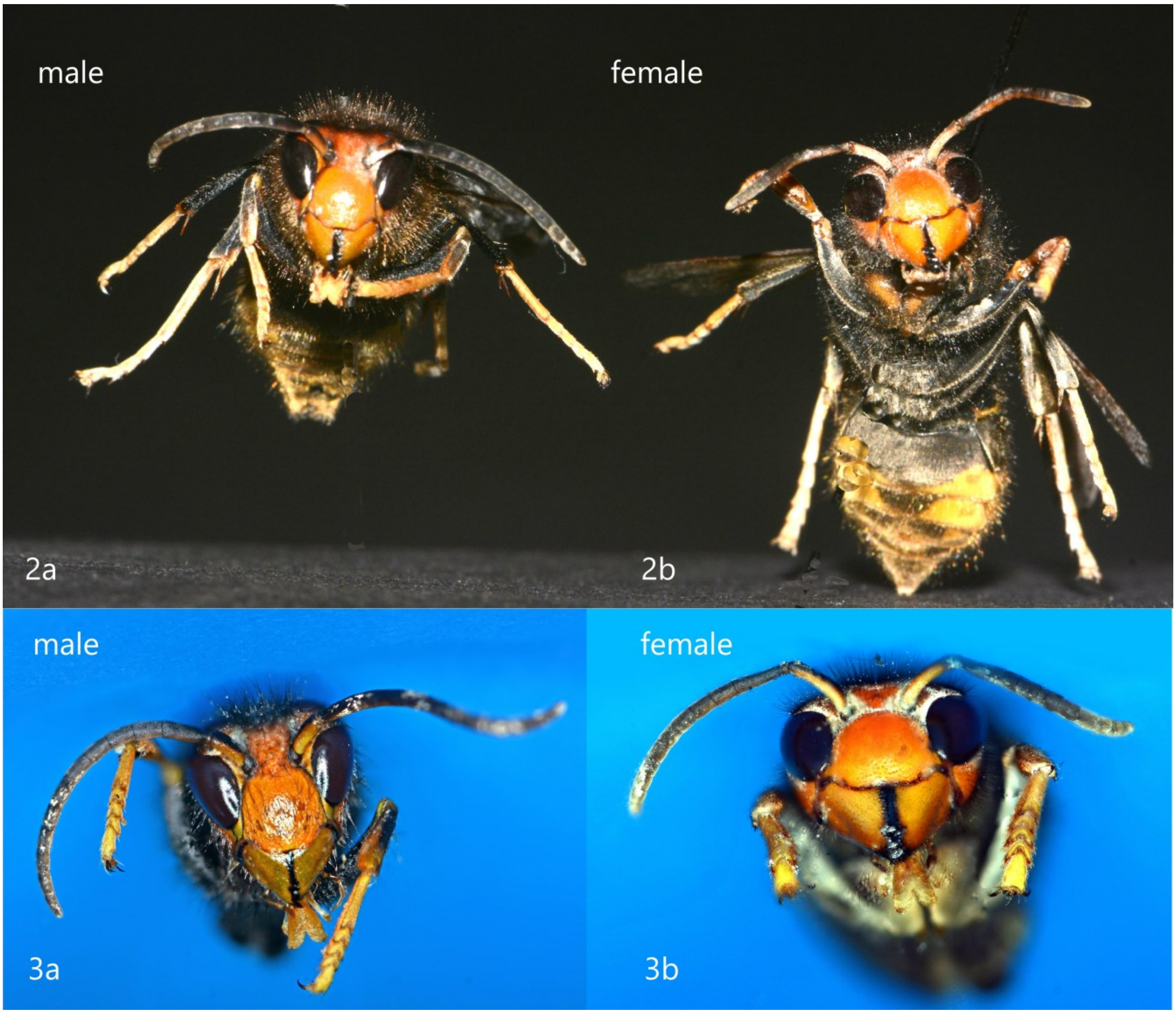


Fig. 2. Habitus; a, male; b, female. © Michel Asperges.

Fig. 3. Head; a, front view on the head of the male; b, female hornet. © Michel Asperges.

In the following text and photos, we have tried to gain more insight into the morphology (external characteristics) of the animal and, where possible, to find a connection between structure and function. You can find a lot on the internet or in magazines about its life history. This is especially important for beekeepers, as honeybees are the first victims of these voracious wasps. Interesting data can be found in Villers V. & Schoonvaere (2019) and Honeybee valley Ghent (2018). But information about the relationship between the structure and function of morphological parts is limited. This article aims to fill in some of the gaps to understanding the morphology of *Vespa velutina* and to link the morphological parts to the functional activity of this insect species.

Working method

During the course of autumn 2020, two nests were found in and around Leuven. The fire brigade destroyed these nests with "Permas-D" poison and collected the wasps. They provided us with some of the wasps, stored in ethanol 95°. A disadvantage was that the powder used to destroy the wasps proved problematic when it came to photographing them: it stuck everywhere in the hairs.

Once the wasps were sorted according to sex, they were bleached for several days in a 10% KOH solution. This solution was repeatedly renewed. The bleached specimens were stored in ethanol 95°.

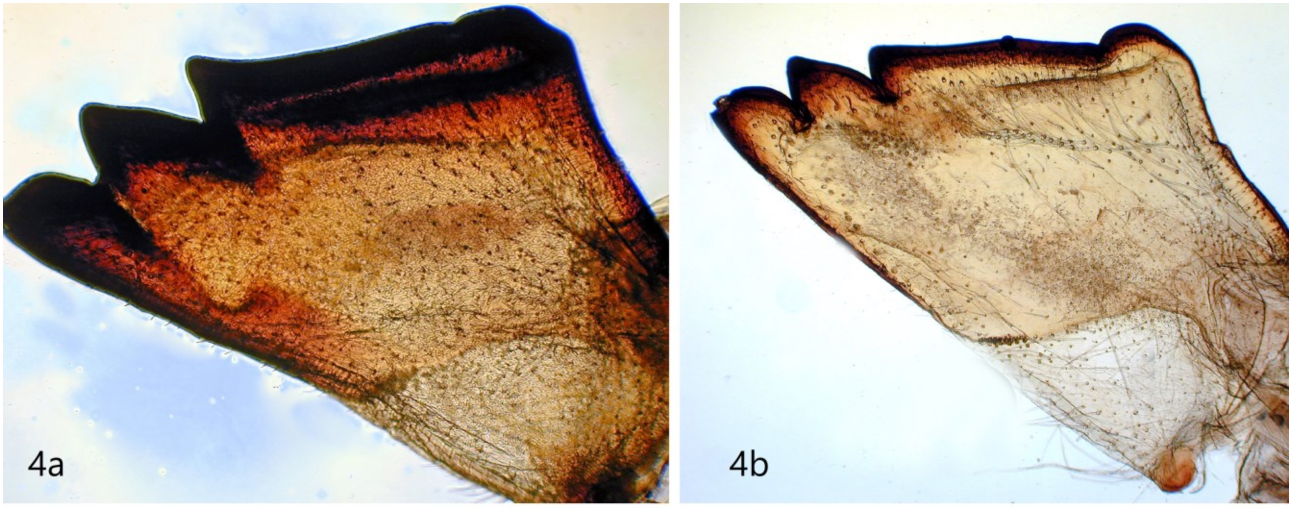
In this study, we used an Olympus CH2 and a Zeiss "Primo Star" light microscope. The photos were taken with a Nikon Coolpix 950 and a Nikon D7100 with a macro lens Nikon 105 mm camera. For financial reasons, it was not possible for us to use SEM (scanning electron microscopy).

Results

Head

Mouthparts (Figs 3–12)

The mouth parts immediately betray that the hornet is very well equipped for biting, chewing, and being mechanically active (building with wood, paper). It is quite difficult to disassemble, in an undamaged way, the mouthparts, rather complex in composition.



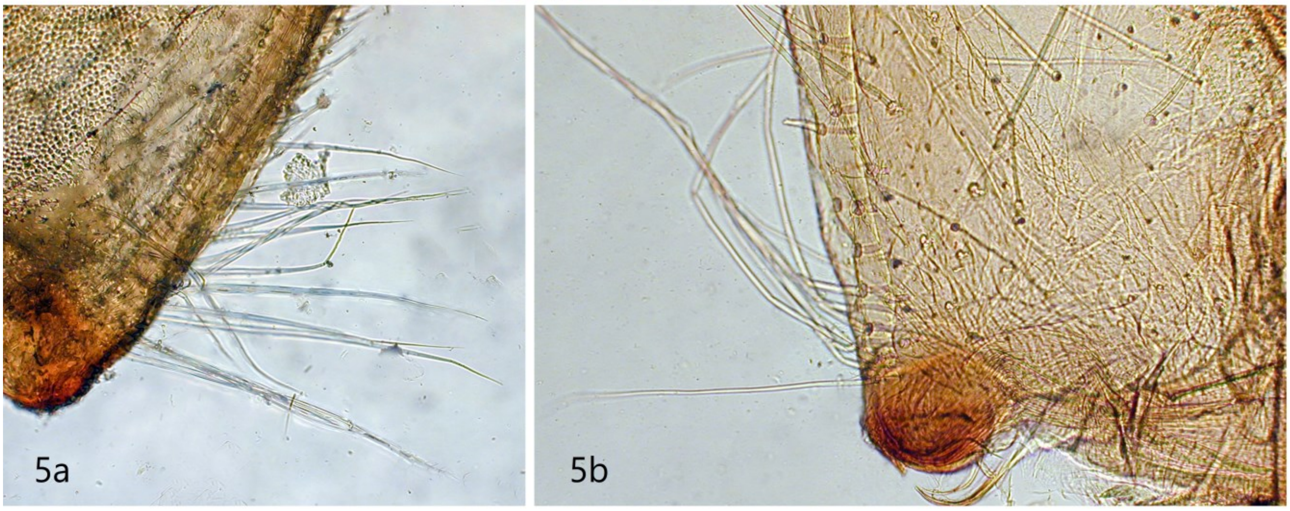


Fig. 4. The jaw; a, the lower jaw of a worker wasp; b, the narrower and smaller jaw of a drone, 40×. © Michel Asperges.

Fig. 5. The lower jaw; a, a worker wasp; b, a drone, 100×. © Michel Asperges.

Jaws (Figs 4–7)

We agree with Baranek *et al.* (2018), who describe dimorphism between workers and drones regarding the jaws. The mandibles (maxillae) of the females are a bit longer and wider than those of the males. On the lower jaws, there are a whole series of short, thin hairs. The lower cusp has long, single, thin hairs. The jaw edge has 3 sharp, dark points. The edges of these points are grooved and provided with short, thick hairs. Probably all this promotes prey retention. Both yellow-brown lower jaws fit together perfectly. When resting, one jaw is always slid under the other.

The upper jaws (mandibulae) bear rather long jaw probes, composed of several limbs. Similar palps are found on the lower lip (labium), but they are much shorter than those of the upper jaw. The antennae play an important role in gripping a captured victim.

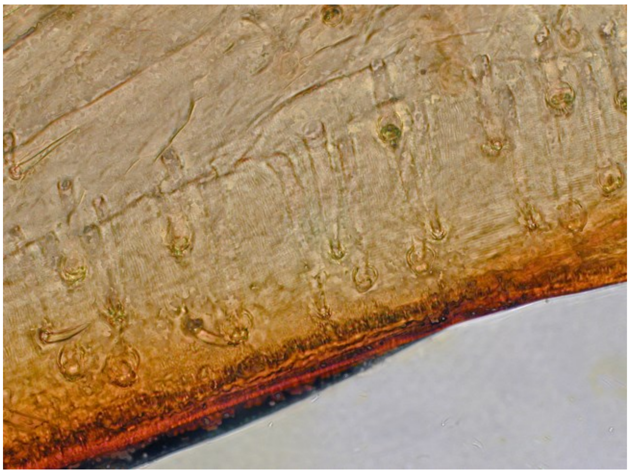
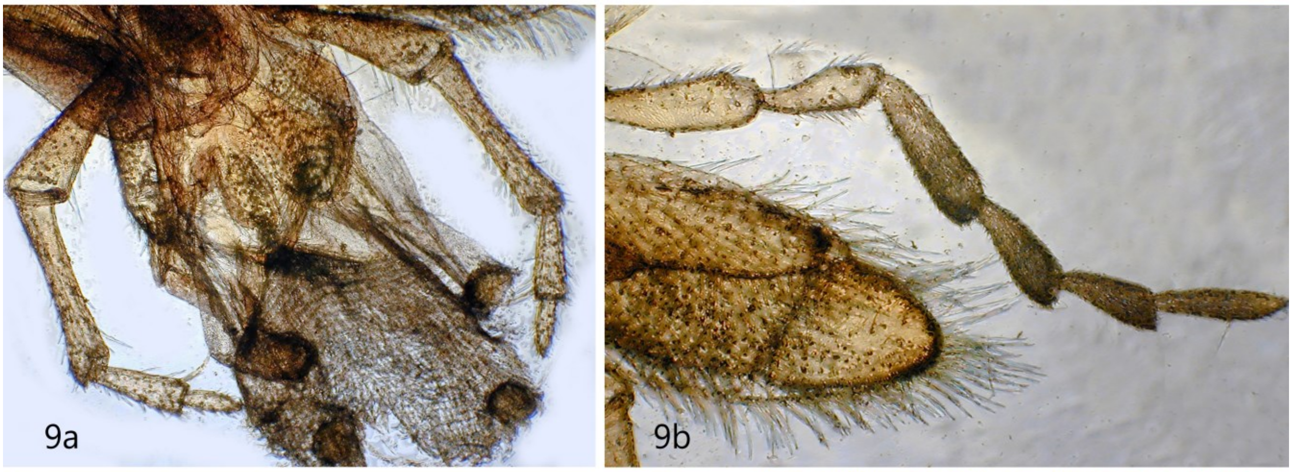


Fig. 6. The edge of the lower jaws is grooved and has short thick hairs, 400×. © Michel Asperges.

Lips (Figs 8–12)

The hornet has a small upper lip (labrum) and a fairly large lower lip (labium). The lower lip consists largely of the tongue (ligula) which itself consists of two parts: the glossae, with the paraglossae on the side. This makes the fairly long lower lip at the front appear to be partially split in two. This is especially evident when the hornet is anesthetized with ether and killed. Microscopically we see round, semi-spherical structures on the left and right of the glossae and paraglossae, often provided with single, stiff, curved hairs (sensillae). Dade (1962) and later Baranek *et al*. (2018) call these hemispherical structures taste buds or tongue knobs (acrosomal button in English).



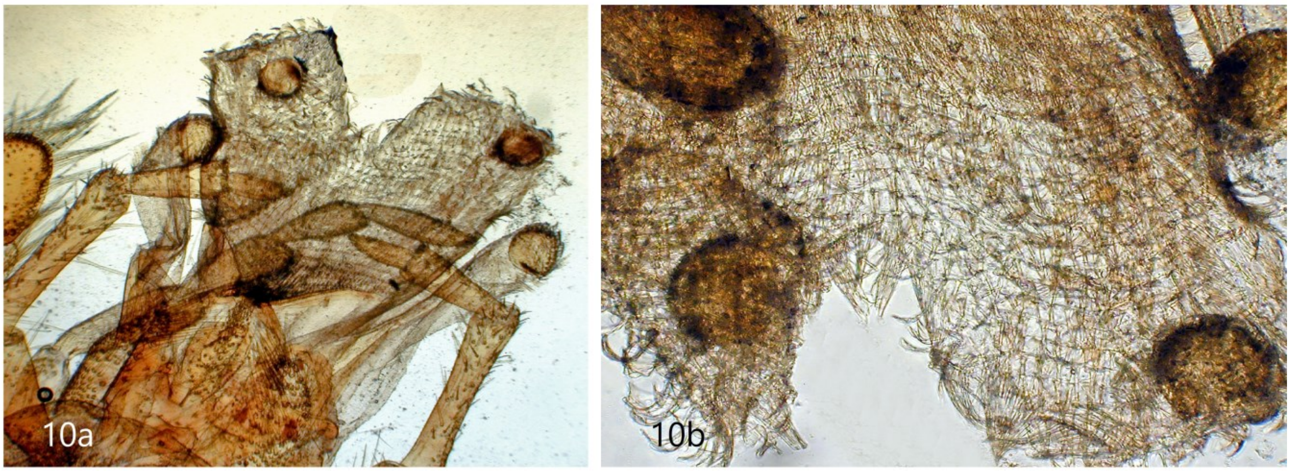
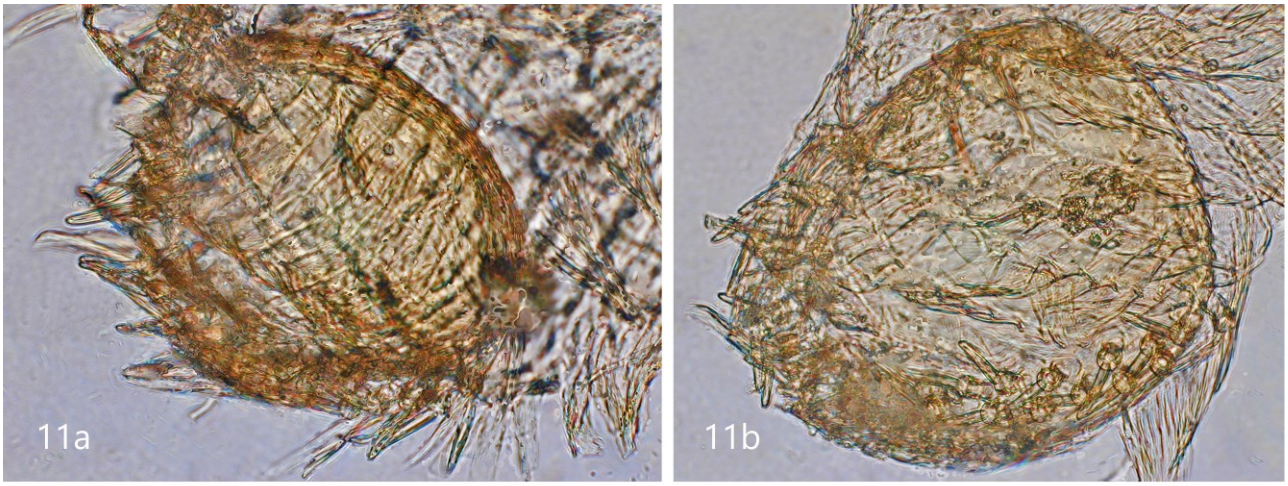


Fig. 7. Head of a worker wasp at rest; one upper jaw slides under the other upper jaw. © R. Vaes.

Fig. 8. Upper jaws and the tongue. © Michel Asperges.

Fig. 9. Jaws and the lower lip; a, overview of jaws and lower lip with tongue and jaw probes, 40×; b, the lower lip probe consisting of different segments or lids, 40×. © Michel Asperges.

Fig. 10. The lower lip and the taste buds; a, the lower lip consisting of glossae and paraglossae and the jaw probes, 40×; b, the taste buds or tongue nodules, 100×. © Michel Asperges.



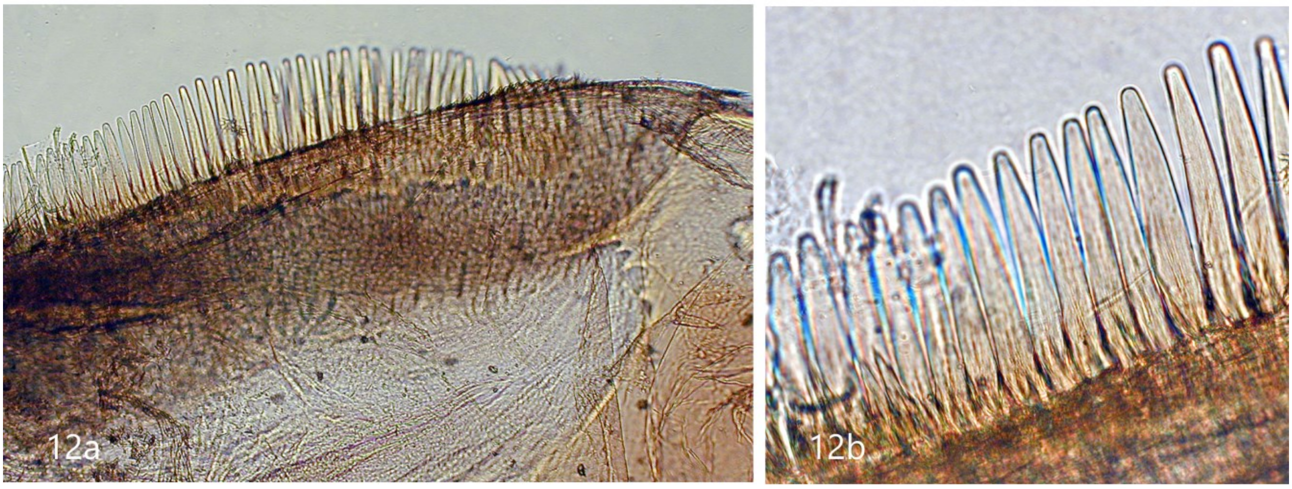


Fig. 11. Detail of a taste bud, 400×; a, top view; b, bottom view. © Michel Asperges.

Fig. 12. Edge of the lower lip with short, thick hairs; a, 100×; b, 400×. © Michel Asperges.

The work of Baranek *et al*. (2018) contains beautiful SEM images of the taste buds but we have not found any description of them in the literature. They play an important role in the sense of touch and taste. The hairs belong to the group of the base sensillae. These taste buds do not occur in honeybees and bumblebees, but they do occur in wasps and hornets.

Antennae (Figs 13–21)

On top of the head, to the left and right of the pointed eyes, are two cylindrical antennae. The antennae of the males are longer (13 limbs) than those of the females (12 limbs). We count the limbs from the knee joint (pedicel) to the top. The limbs or segments (flagellomeres) of the drone are slightly more serrated than those of the females. The segments themselves are separated from each other by a distinct knee joint.

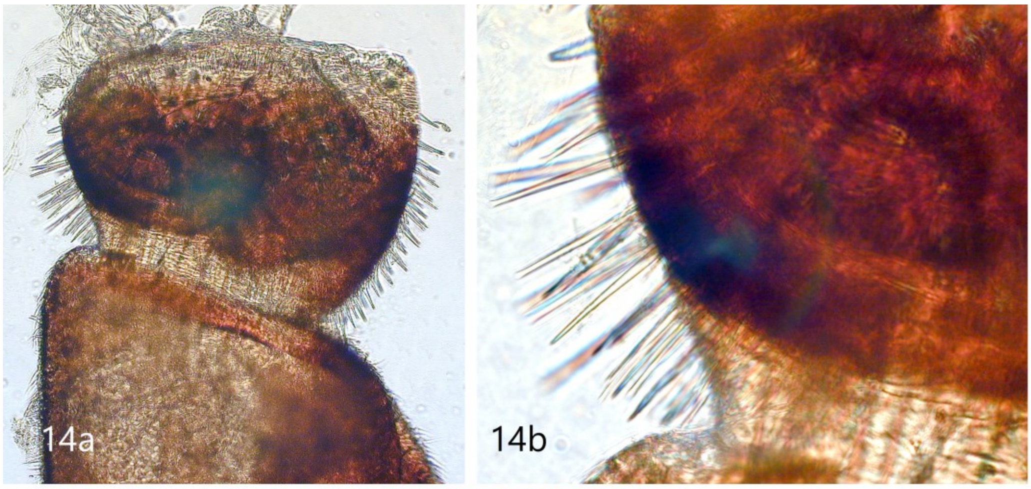
Each antenna is attached to the head with a spherical ball joint, comparable to the honeybee. The numerous stiff hairs on this ball joint play a role in detecting the position of the antennae.

We establish that tracheae and muscle bundles run to the ball joint and we suspect that nerve pathways are also present.

Fig. 13. Overview of the antennae of a drone (longer) and a worker wasp (shorter). © Michel Asperges.

The ball joint connects to the long shaft (scapus) which in turn connects to a small hinge segment or knee joint (pedicel). This knee joint allows the whip to perform upward and downward movements but not to rotate. More towards the top, we find a long, flexible whip (flagellum) that consists of several limbs that are attached to each other by knee joints. The segment that connects with the knee joint or pedicel is longer in males than in females.

 ISSN 0771-5277



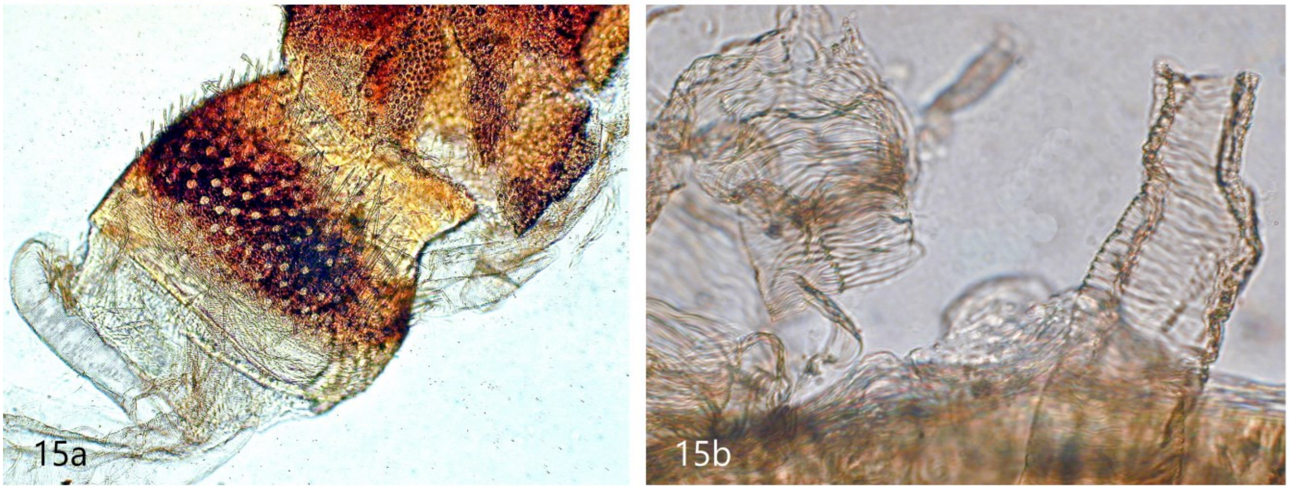


Fig. 14. Antenna; a, ball joint with shank connection 40×; b, stiff feeler hairs, 100×. © Michel Asperges.

Fig. 15. Tracheae leading to the ball joint; a, 100×; b, 600×. © Michel Asperges.

Sensory organs on the antennae (Figs 20, 21)

Every segment or member of the antenna is covered with sensory organs. Just like in the honeybee, the bumblebees, and the solitary bees, every segment is occupied with numerous smell and scent plates and small tasting hairs that are microscopically difficult to see. The use of SEM could certainly offer a solution here.

We know from the honeybee (Asperges *et al*. 2020) that these are smell organs (placoid sensilla/sensilla placodea) and touch or feeling organ sets with short, thick hairs (sensillae) that are very variable in length, shape, and thickness. They are mechanoreceptors (movement and touch) or olfactory receptors (odour) that are always connected via sensory nerve cells to the sensory nerve that runs to the brain. In addition to hair, there are also smell, flavour, and fragrance plates (placoid sensilla/sensilla placodea). In the honeybee, these plates are rather round to light elliptical; while in the Asian hornet, they are long elliptical, somewhat indented, and especially thick-walled. It is not yet clear how many odour plates occur per member and whether the drones have more than the workers and the queens.

Ocelli

Pointy eyes (Fig. 22)

On top of the head, in the shape of a triangle, there are three, pointy eyes with a transparent lens. Without a darkroom, no imaging is possible. According to Dade (1962), they only capture the light intensity. This is how they determine behaviour e.g., flying out to forage and to aid in orientation. Similar pointy eyes also occur in bumblebees, solitary bees, and honeybees.

Facet eyes (Fig. 23)

Like all insects, the Asian hornet has very large, faceted eyes. The facets are hexagonal but not as uniform as in the honeybee and the bumblebee. In the honeybee, there are single hairs between the facets, which are largely missing in the hornet. Each facet is bounded on the outside by the cornea, which itself consists of many small, hexagonal lenses. Each of these lenses is connected to a single eye (ommatid). Given the very large number of lenses, the hornet does not see a nice clear image as humans do. However, the imaging is enough to get an idea of the environment and enough detail of the prey they want to catch.

Thorax

The thorax has two pairs of wings and three pairs of articulated legs.

Wings (Figs 24–30)

The Asian hornet belongs to the 'Fold-winged wasps' which means that the two pairs of wings are always folded

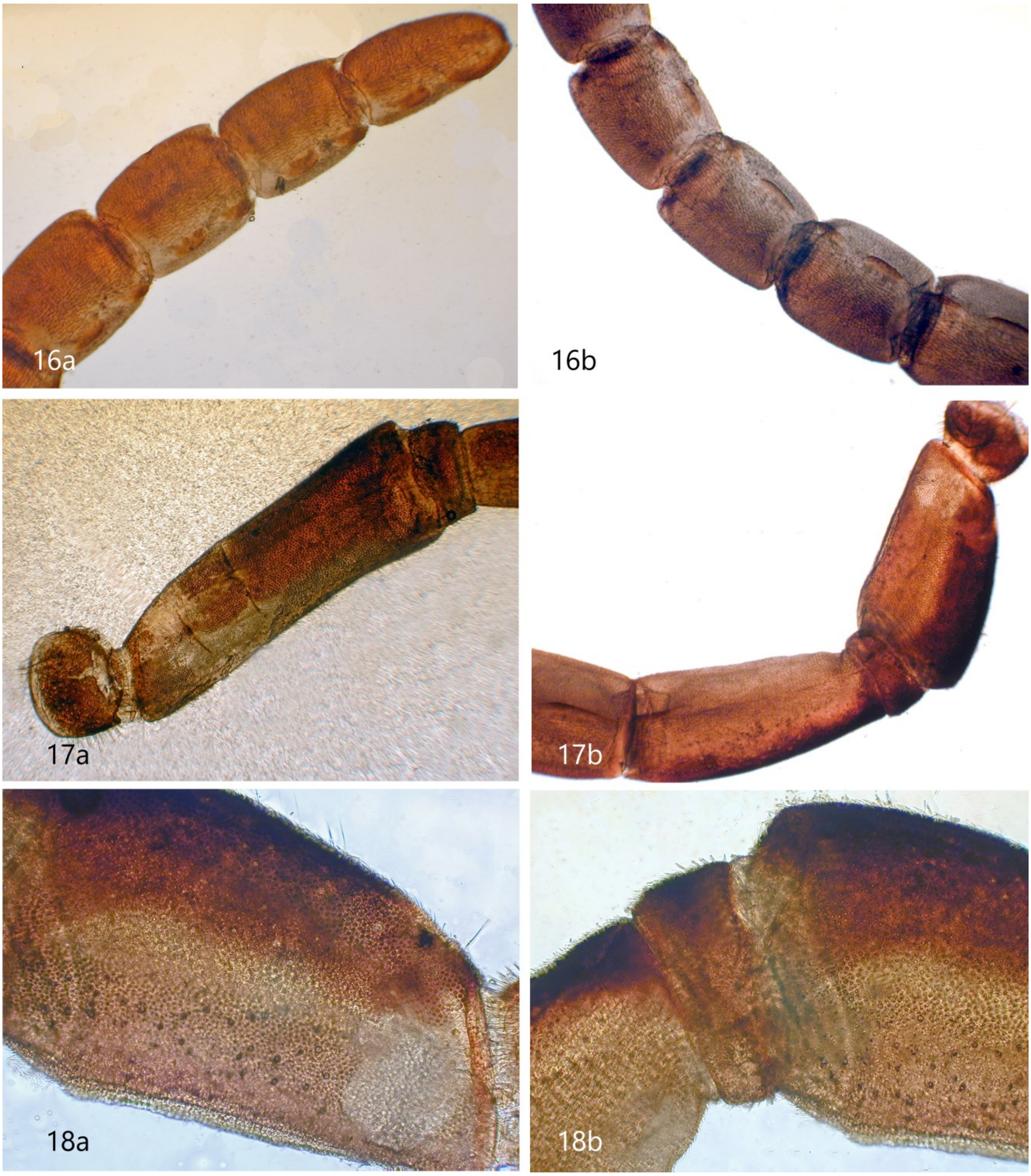
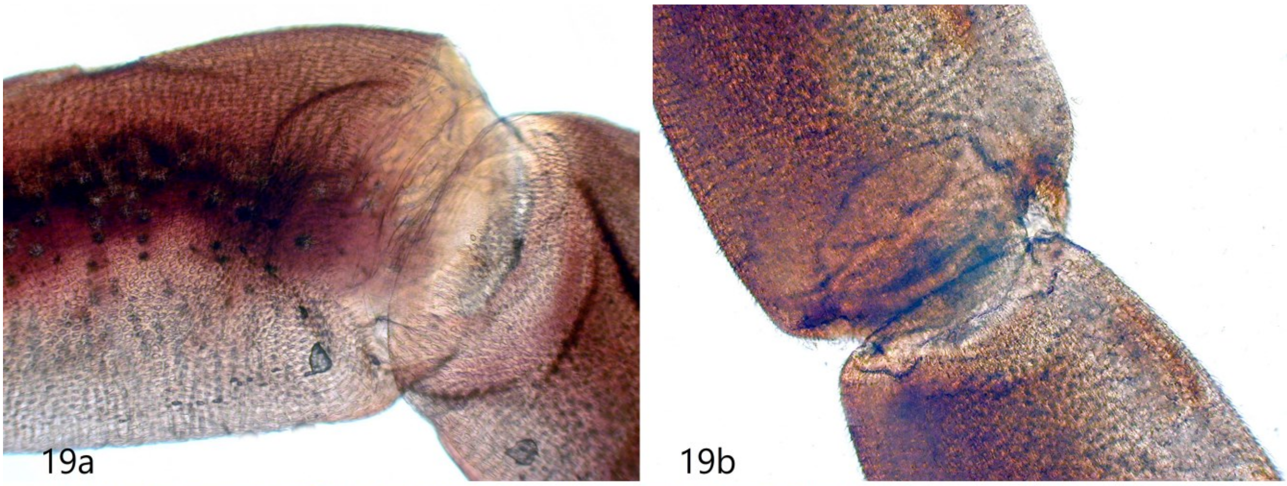
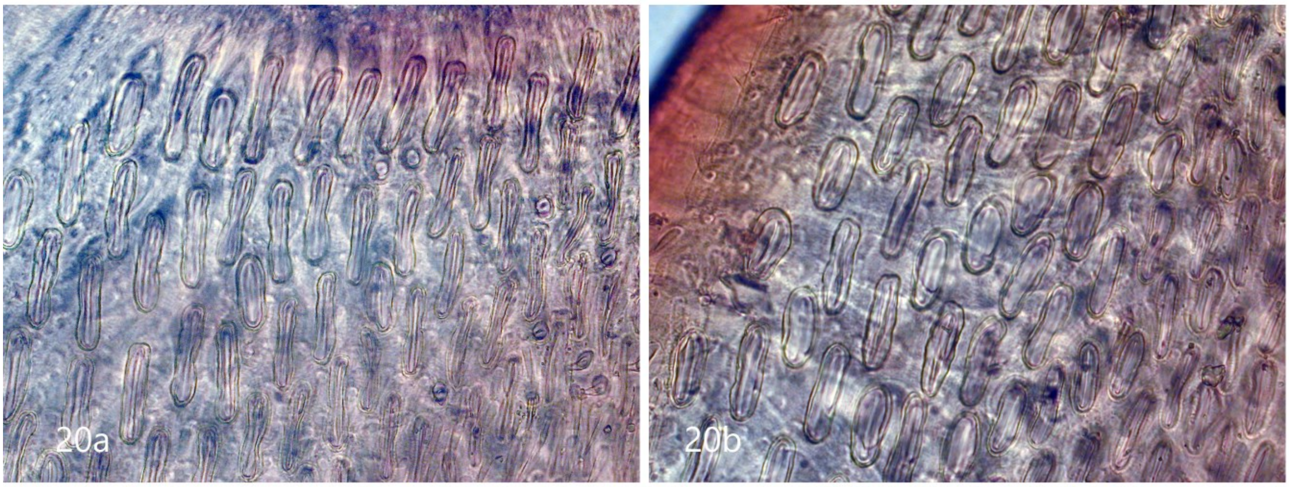


Fig. 16. Antennal segments; a, b, different segments of a worker's blade from the top, 40×. © Michel Asperges.

Fig. 17. Ditto; a, the ball joint, the shank with knee joint; b, the longest segment of the antenna of a worker wasp, 40×. © Michel Asperges.

Fig. 18. Ditto; a, the shaft, 100×; b, centrally the hinge segment or the pedicel connecting the shaft with the last segment, 100×. © Michel Asperges.





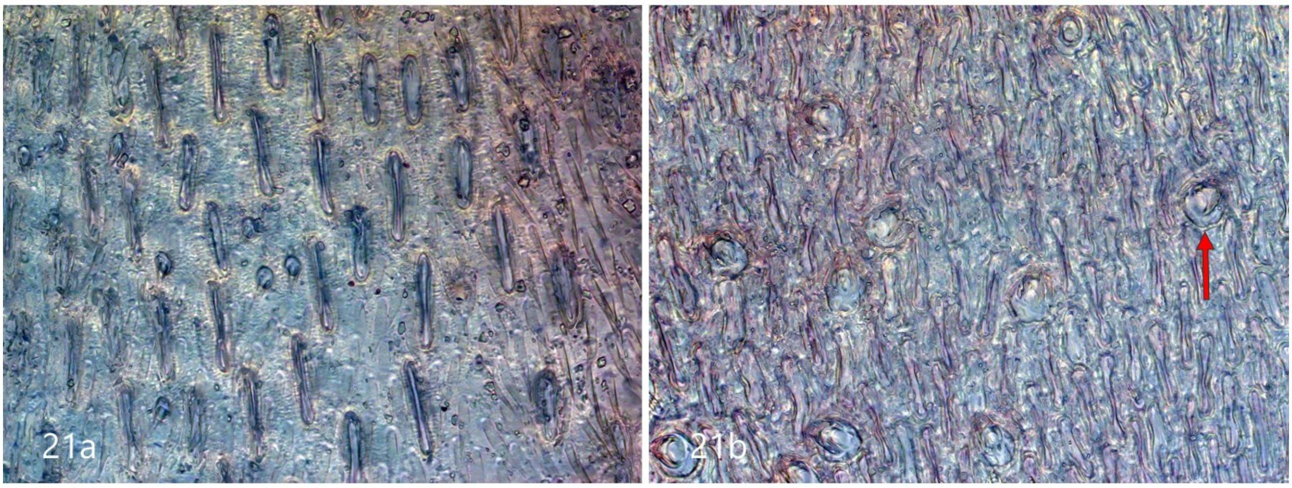


Fig. 19. Joint; a, b, joint between shaft and pedicel, 100×. © Michel Asperges.

Fig. 20. Taste and fragrance plates; a, in the drone; b, in the worker, 600×. © Michel Asperges.

Fig. 21. Ditto; a, taste and fragrance plates; b, a few stiff hairs in top view (round hair bases are indicated with red arrow), 600×. © Michel Asperges.

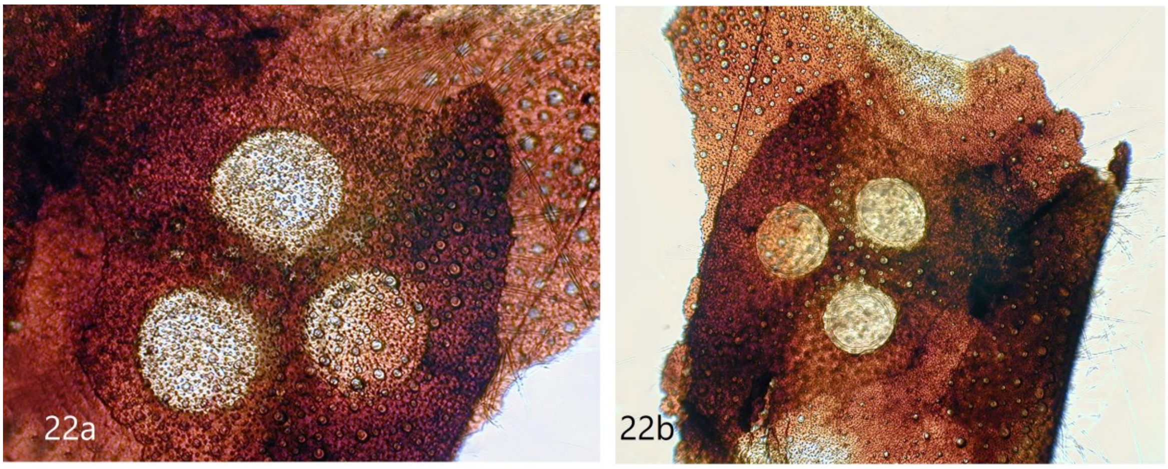
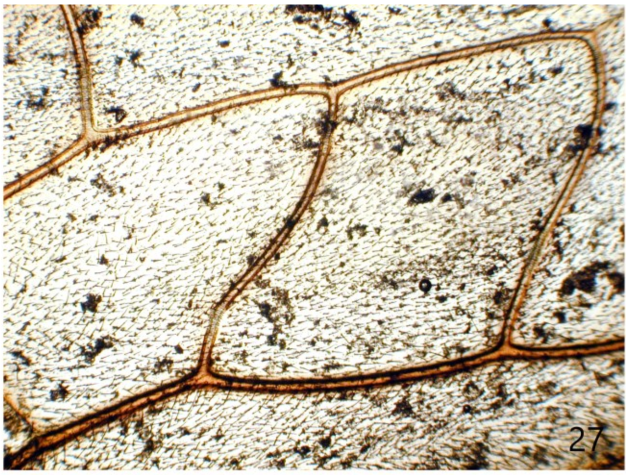


Fig. 22. Pointed eyes; a, b, three pointed eyes in top and bottom view, 100×. © Michel Asperges.

Fig. 23. Facet eye; a, overview of facet eye; the outer edge is the cornea, 40×; b, detail facets, 400×. © Michel Asperges.

Fig. 24. Wings; a, the wings at rest; b, the wings while flying. © Michel Asperges.



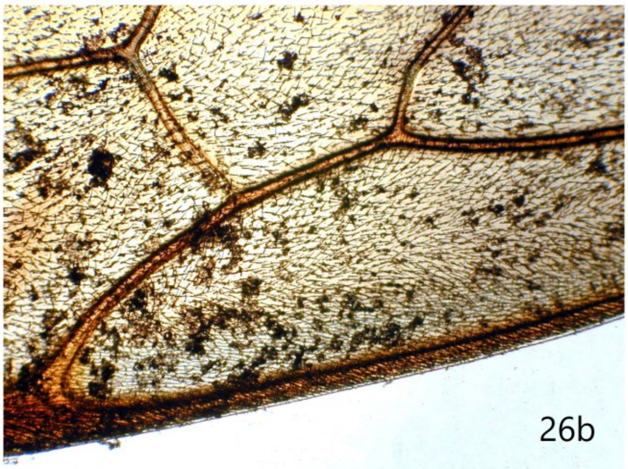


Fig. 25. Striated muscles at the base of the wing, 40×. © Michel Asperges.

Fig. 26. Vein and marginal cell; a, chitinous vein with haemolymph, 600×; b, the edge cell or marginal cell of the anterior wing, 100×. © Michel Asperges.

Fig. 27. Chitinous cells of the front wing, 100×. © Michel Asperges.

together when resting, in contrast to the honeybee and bumblebees where the two pairs of wings are always folded open. The wings are attached to the thorax with many striated muscles. The haemolymph runs through the wings in thick, brown, hollow, chitinous veins. These veins line the different 'cells' such as the edge or marginal cell and the cubital cells.

Like in the honeybee, the two wings hook together during flight. The smallest wing attaches with hooks behind the thick border of the forewing. There are three types of brackets: curled brackets close to the point of attachment of the hind wing (about 7), ventrally curved brackets (12 to 14), and straight brackets at the end (5 to 7). The surface of the wings has single, straight hairs at a certain angle; presumably, they play a role as stabilizers. A lot of dust can get stuck between these hairs.

Legs (Figs 31–33)

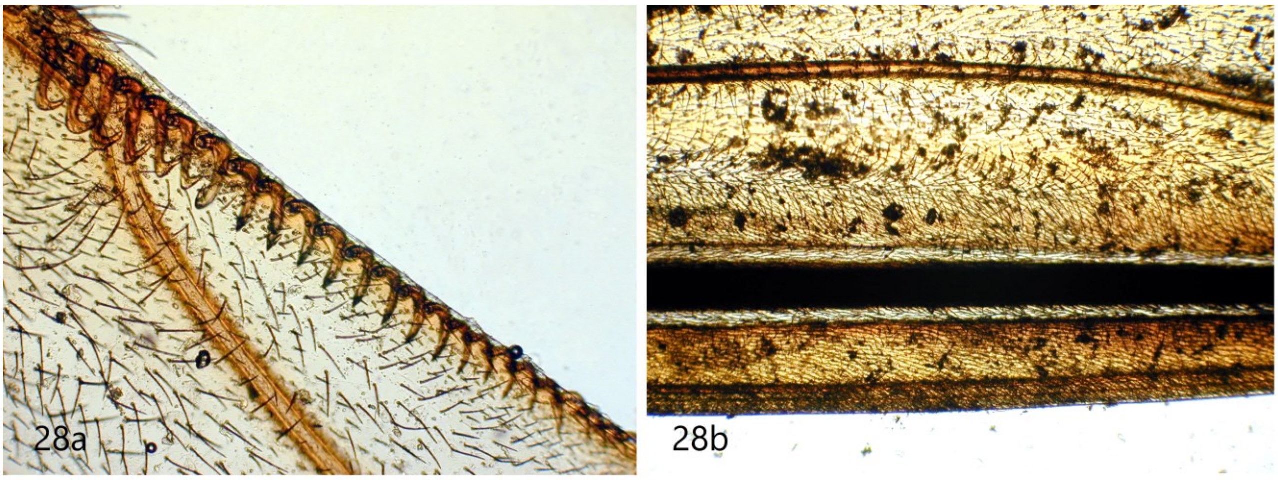
Like all insects, the hornet has three pairs of articulated legs attached to the thorax. Each leg consists of the hip ring (coxa) connected to the thigh ring (trochanter) which in turn is connected to the thigh (femur) and further to the shin (tibia), and finally to the foot. The foot (tarsus) itself consists of five parts (tarsomeres). The first and longest member, the basitarsus, is connected to the shin. This is followed by three metatarsa and finally the fifth and last foot member: the pretarsus. Important parts of the pretarsus are the two claws and the arolium (pulvillus). A thick tendon runs through the foot that starts from the shin and thigh muscles. The first member, the basitarsus, is quite long and clearly differs from that of the honeybee and bumblebees. This difference can be explained by the fact that this wasp does not need to collect pollen.

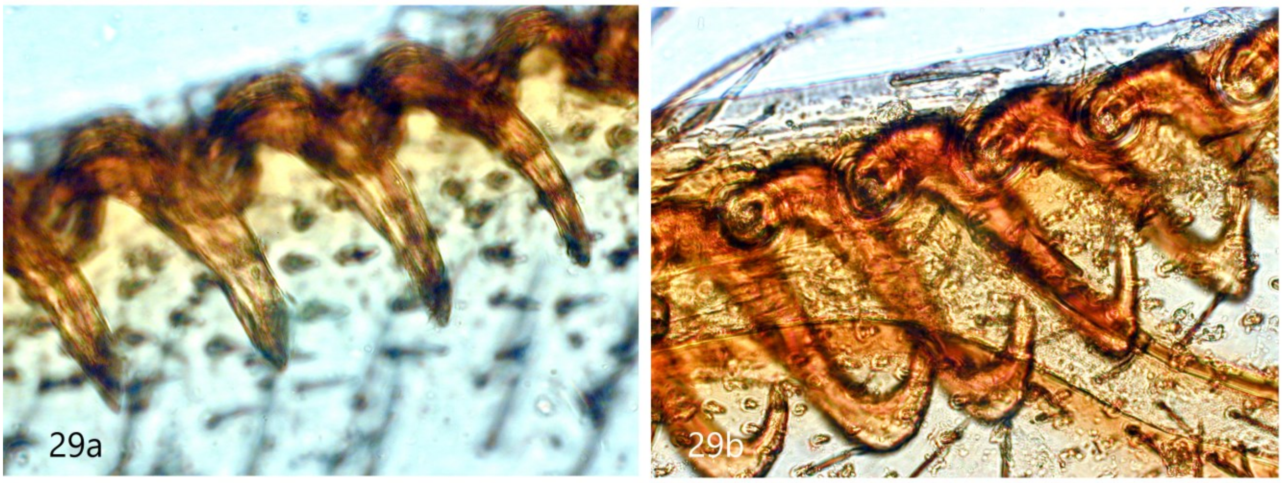
Claws (Figs 34–37)

At the front of the pretarsus, around the suture or arolium, are two pairs of claws. On top of the claw close to the arolium and manubrium is a very long, thick hair on the left and right. We suspect that these two hairs play a mechano-sensory role. The surface of the pointed claws has parallel grooves.

Adhesive patch or arolium (Fig. 38)

Between the two pairs of claws, we see a thin-walled, bubble-shaped structure: the adhesive patch or arolium, which is incorrectly called an adhesive disc or suction cup. It is a grooved bladder that plays a role in clinging to smooth or uneven objects. On coming into contact with an object, if the claws are unable to attach, the arolium inflates immediately, allowing attachment. Would pheromones be secreted along the grooves? The arolium is bordered at the top by a chitinous arch or arcus; and on top of the arolium is a hairy plate: the manubrium.





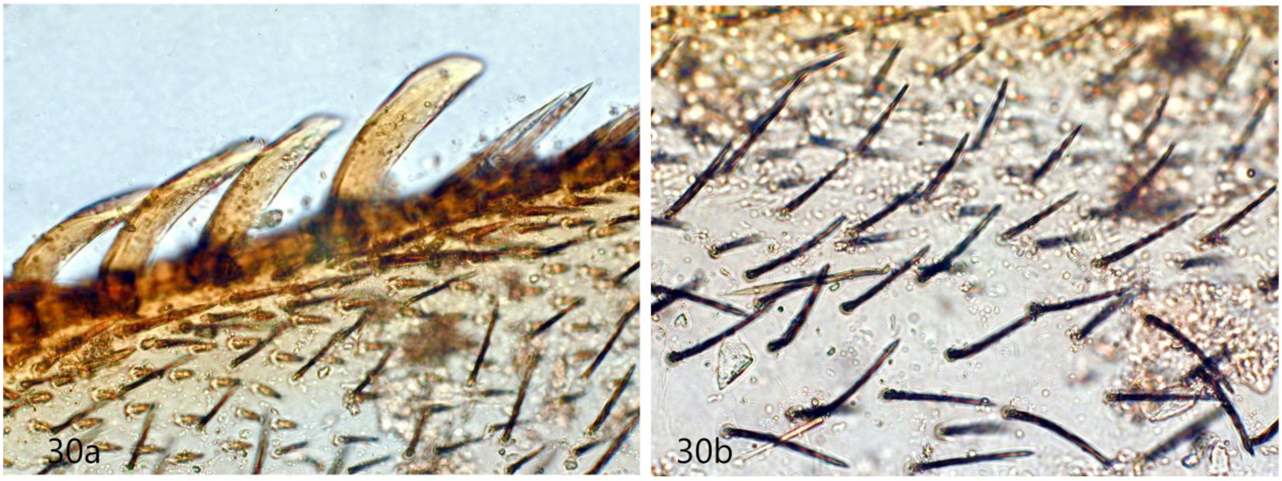
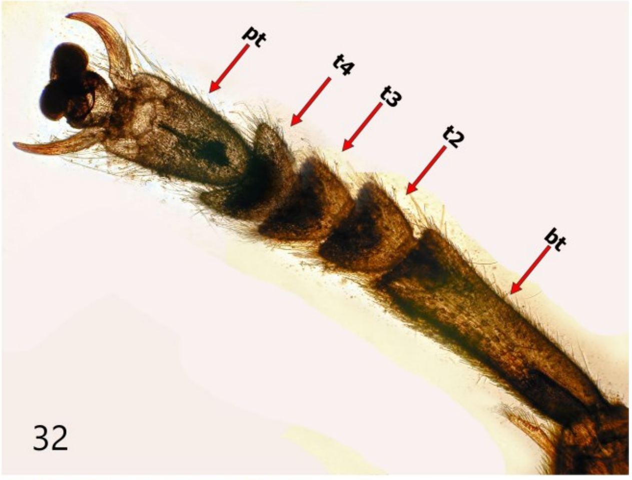
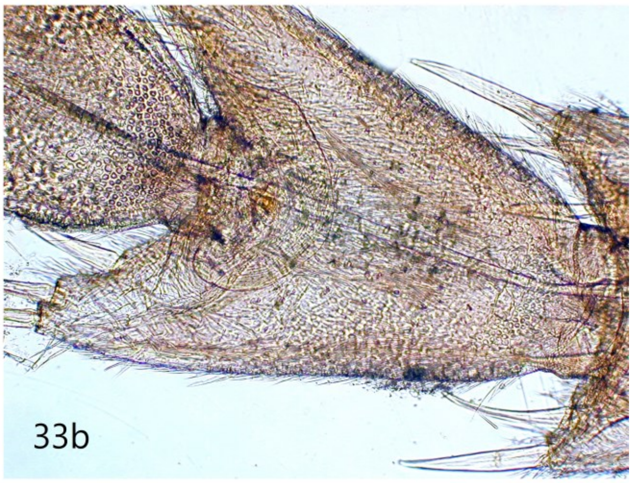


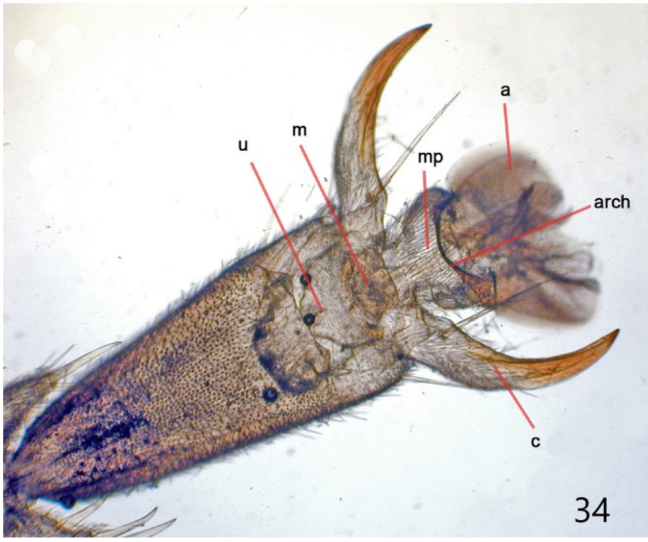
Fig. 28. Wings; a, overview of the brackets on the edge of the rear wing, 100×; b, the thick dark brown bonding edge of the front wing, 400×. © Michel Asperges.

Fig. 29. Ditto; a, first set of curled brackets close to the suture base of the rear wing, 600×; b, the centrally located curved brackets, 600×. © Michel Asperges.

Fig. 30. Ditto; a, short straight hairs on the end of the wing, 400x; b, single, straight hairs at a certain angle on the wing surface, 600x. © Michel Asperges.







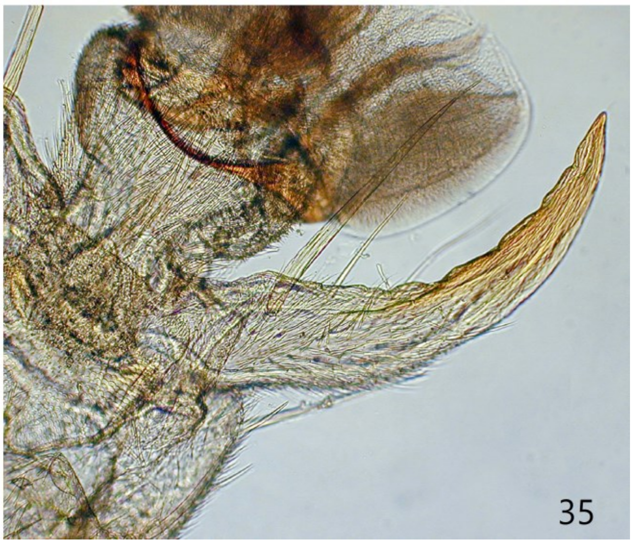


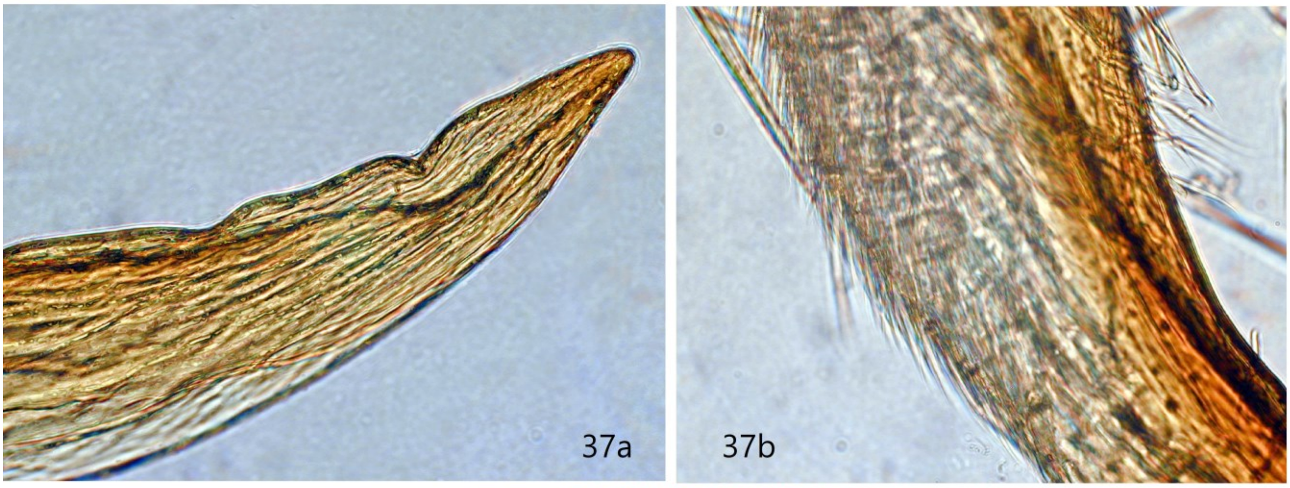
Fig. 31. The three articulated legs: front leg, middle leg and hind leg. © Michel Asperges.

Fig. 32. The foot of the front leg with attachment to the shin with comb, 40×; bt (basitarsi), t (tars), and pt (pretars). © Michel Asperges.

Fig. 33. The tendon running through the tarsus to the pretarsus; a, 40×; b, 400×. © Michel Asperges.

Fig. 34. The pretarsus of the hind leg with the ungitractor (u) and between the two claws (c) of the manubrium (m) followed by the middle plate (mp); arolium (a), arch (ar), 40×. © Michel Asperges.

Fig. 35. The pretarsus of the hind leg with in front the arch and on top of the arolium, 400×. © Michel Asperges.



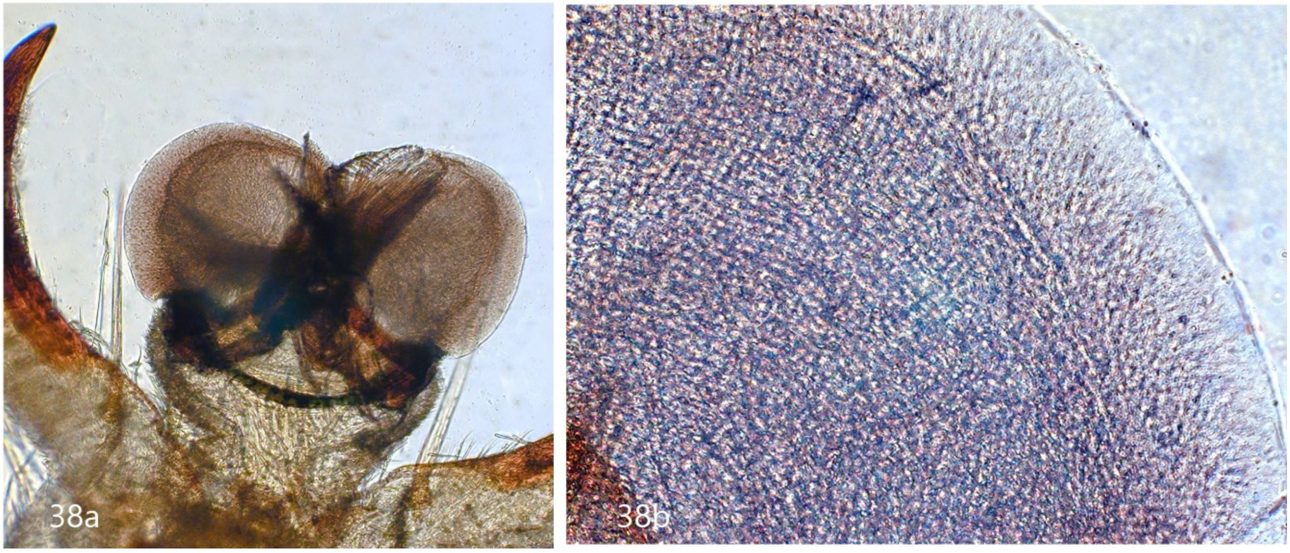
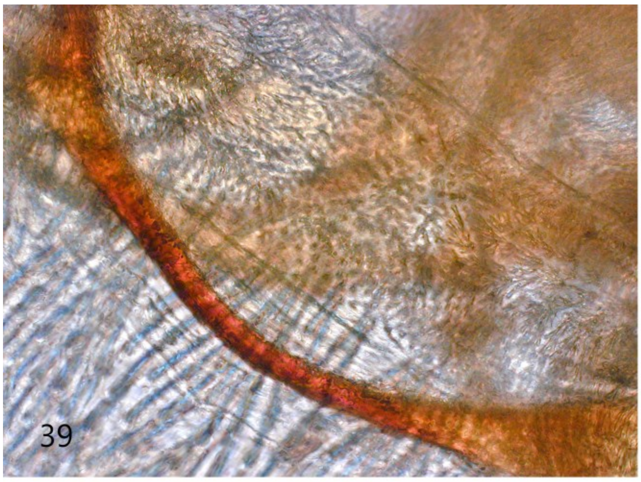
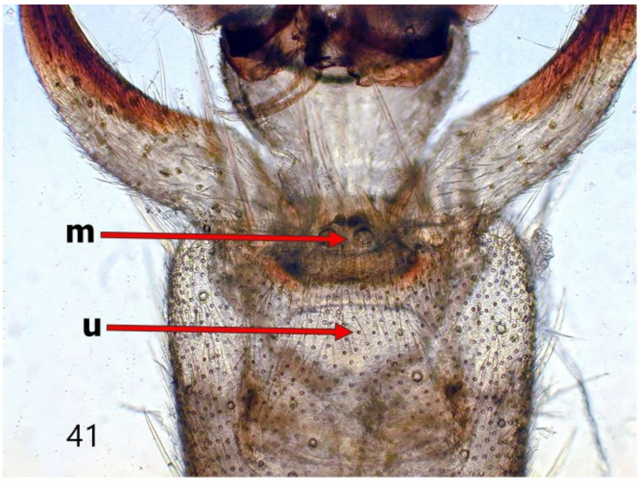


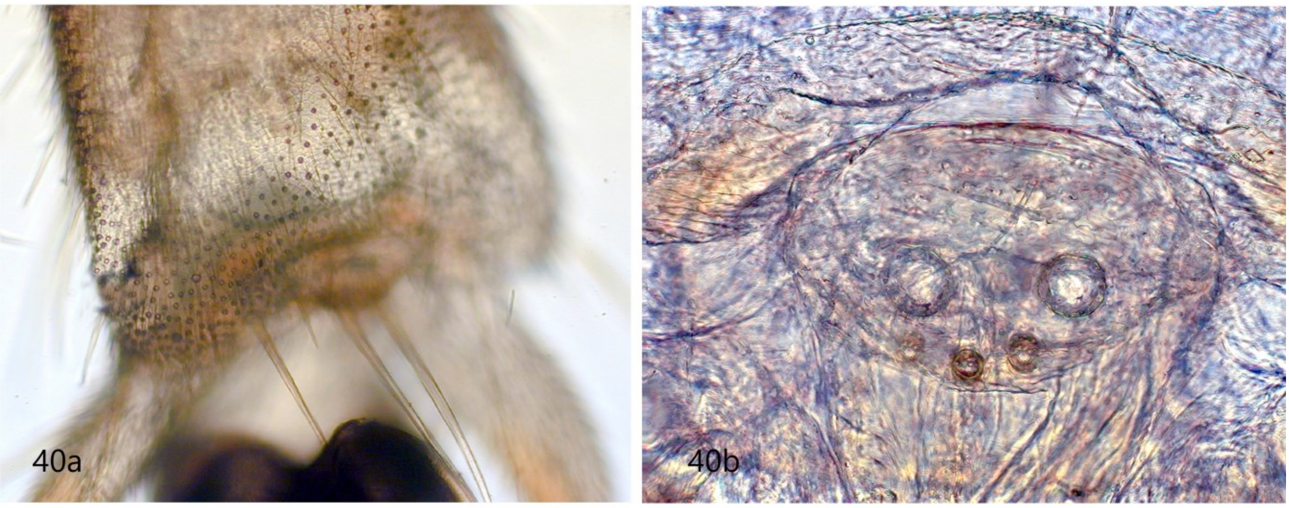
Fig. 36. Claw with long hairs; a, 40×; b, 600×. © Michel Asperges.

Fig. 37. Grooved claw point; a, 400×; b, 600×. © Michel Asperges.

Fig. 38. Arollum; a, overview of arolium or adhesive disc between the jaws 100×; b, the arolium is not smooth but grooved, 400×. © Michel Asperges.







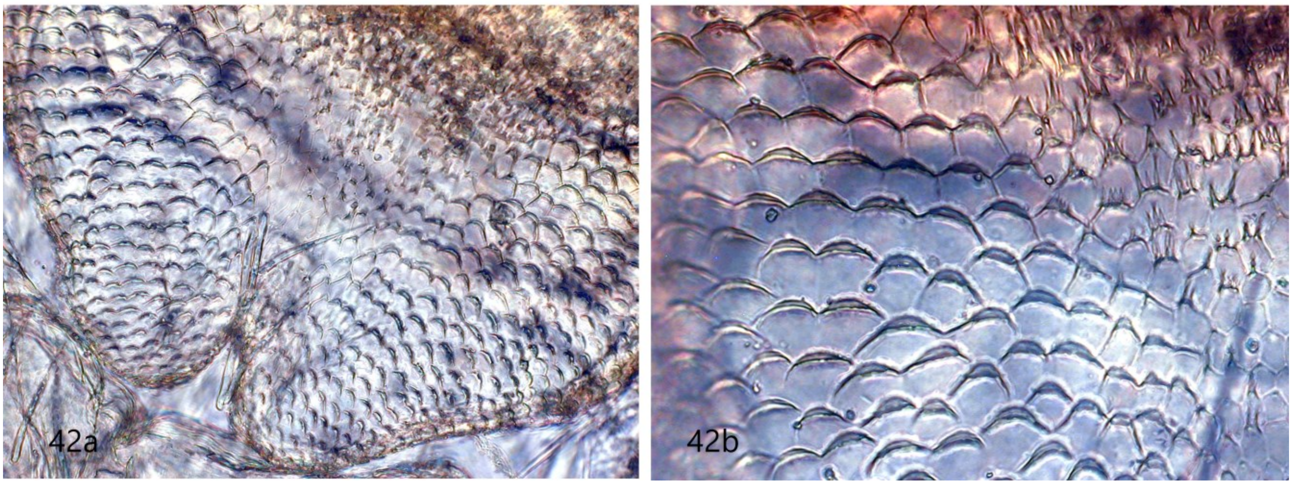
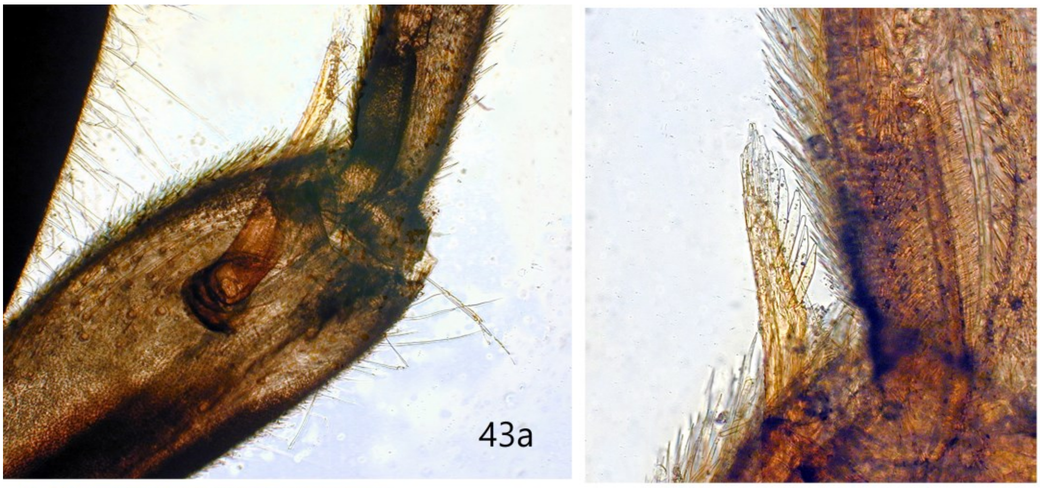


Fig. 39. The arch, 100×. © Michel Asperges.

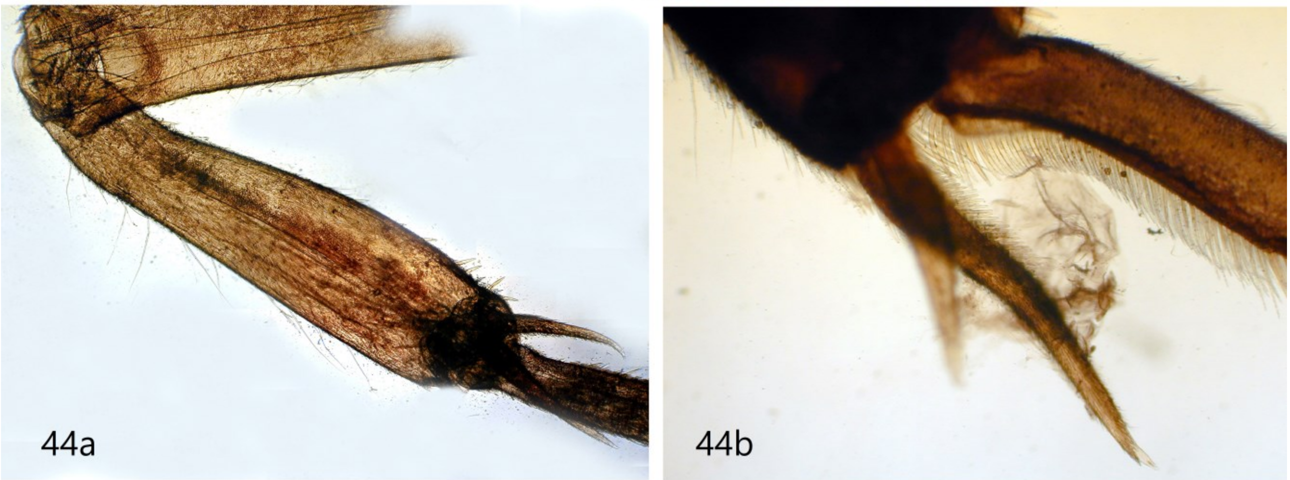
Fig. 40. Manubrium; a, top view of the manubrium located above the unguitractor between the two jaws, 100×; b, detail of top view (the round figures) of the manubrium with the 2 long and the 3 short hairs, 400×. © Michel Asperges.

Fig. 41. Top view of the unguitractor (u) and the manubrium (m), 100×. © Michel Asperges.

Fig. 42. Unguitractor and scaly plate; a, detail of the unguitractor, 400×; b, a clear view of the scaly plate, 600×. © Michel Asperges.



43b



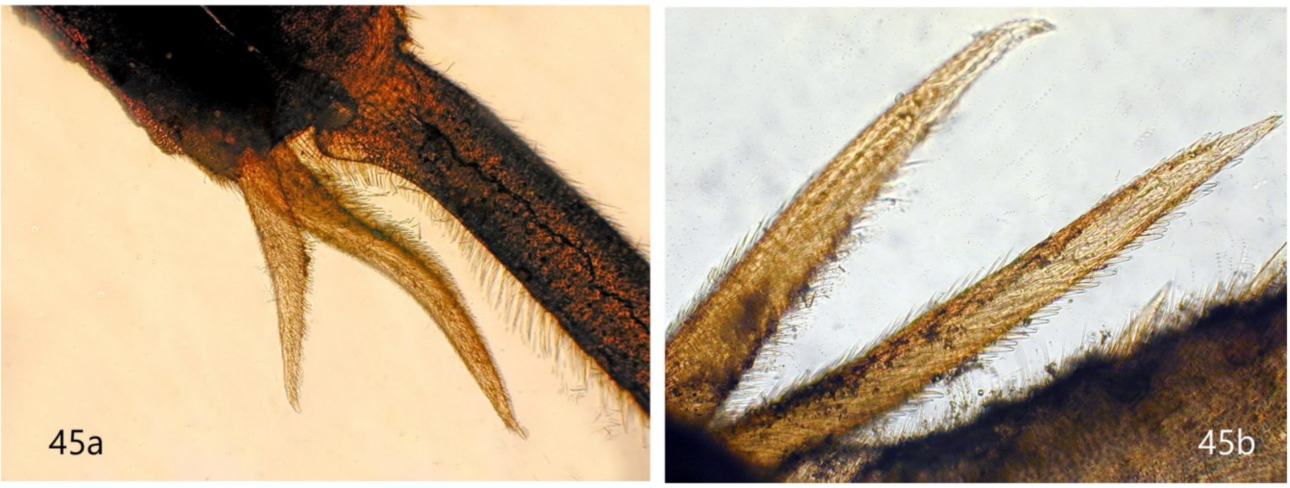
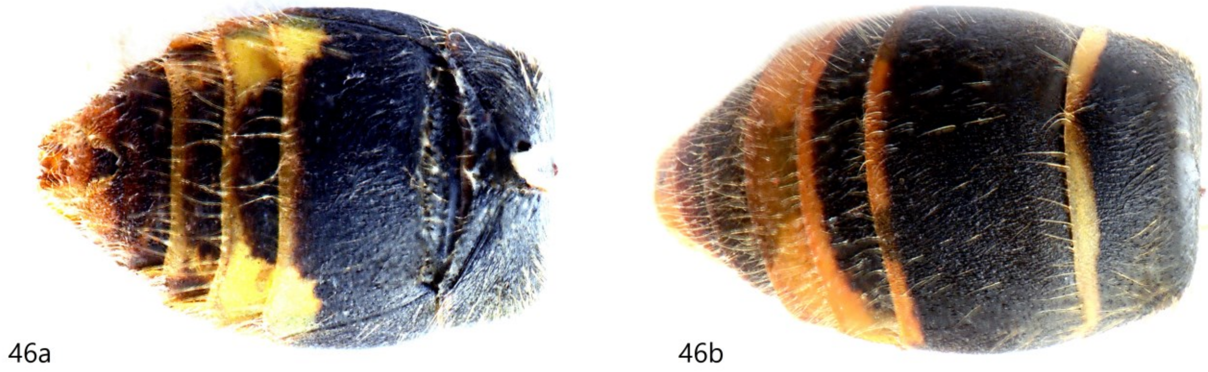


Fig. 43. The comb on the transition basitarsi; a, 100×; b, 400×. © Michel Asperges.

Fig. 44. Two tracks on the transition shone – basitarsi; a, 40×; b, 100×. © Michel Asperges.

Fig. 45. Detail of the two tracks; a, 100×; b, 400×. © Michel Asperges.



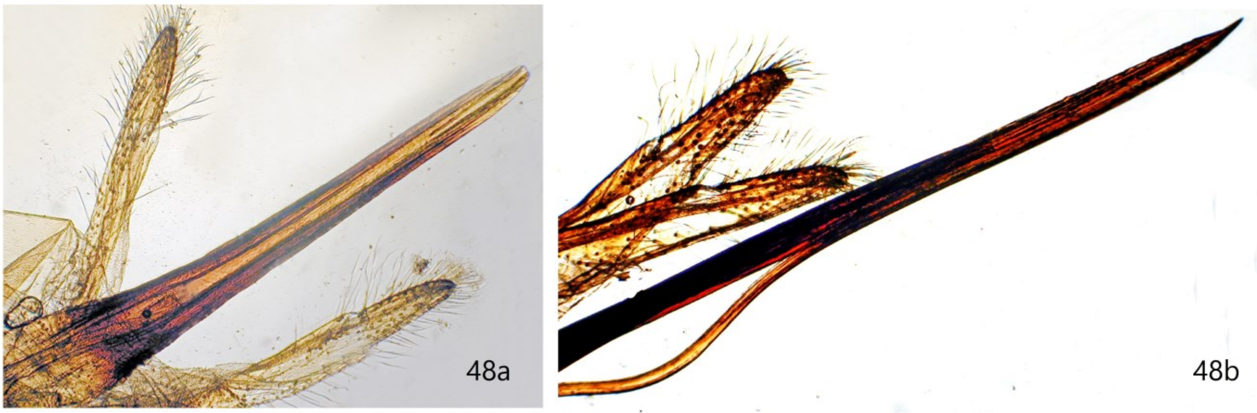
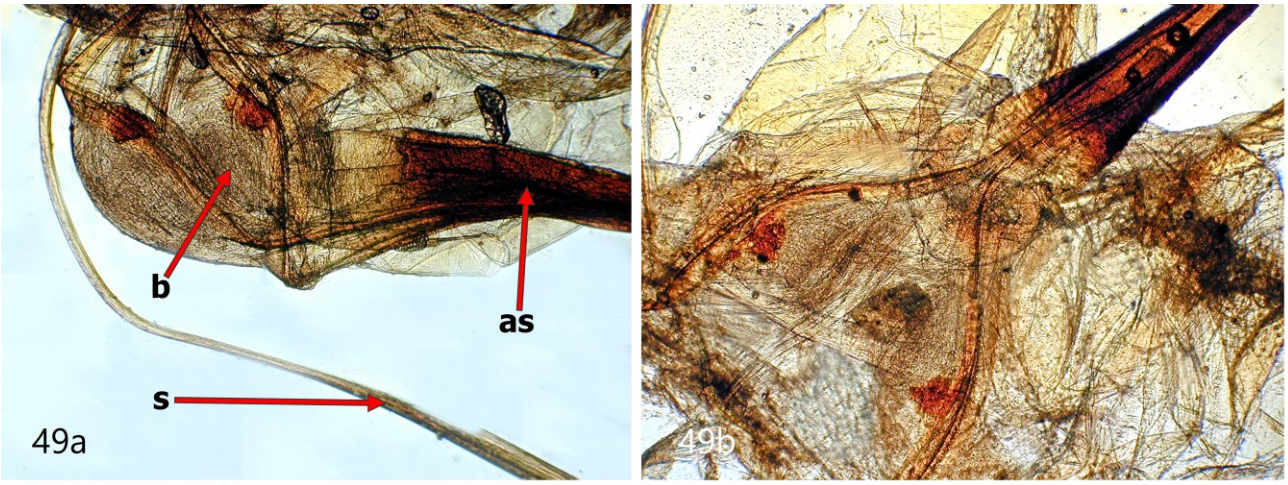
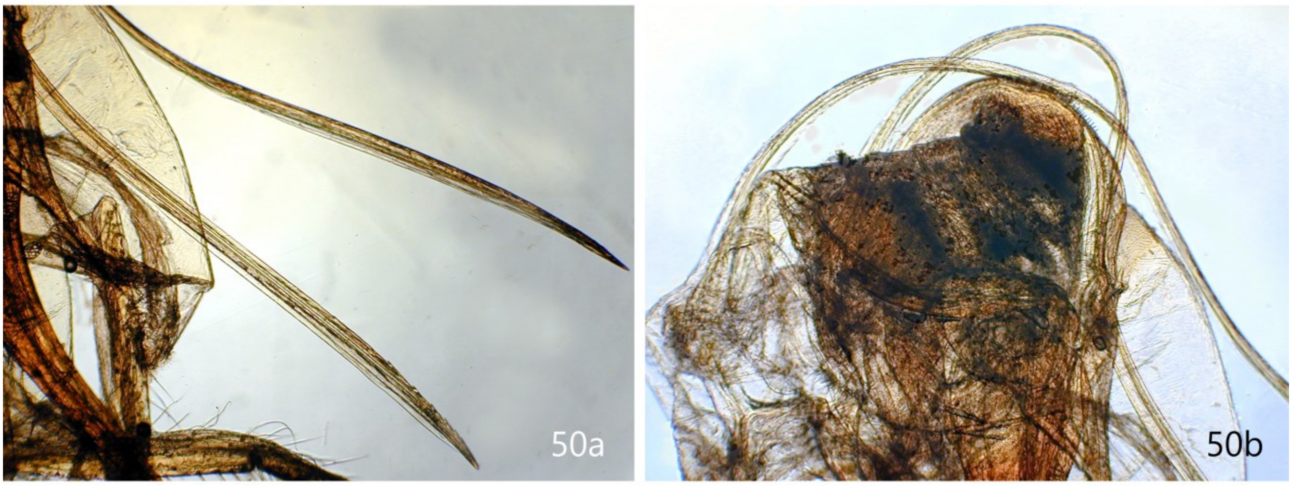


Fig. 46. Sternites and tergites; a, the typical yellow spots on the penultimate abdominal plates (sternites) and the rather blunt end of the drone; b, the back plates (tergites). © Michel Asperges.

Fig. 47. Ditto; a, ventral; b, dorsal side of a worker wasp, without yellow spots on the belly plates and with a sharper end and a stinger. © Michel Asperges.

Fig. 48. Sting; a, overview of the brown sting sheath with the palps on the left and right, 40×; b, the stab needle or lancet sting in the sting sheath, 40×. © Michel Asperges.





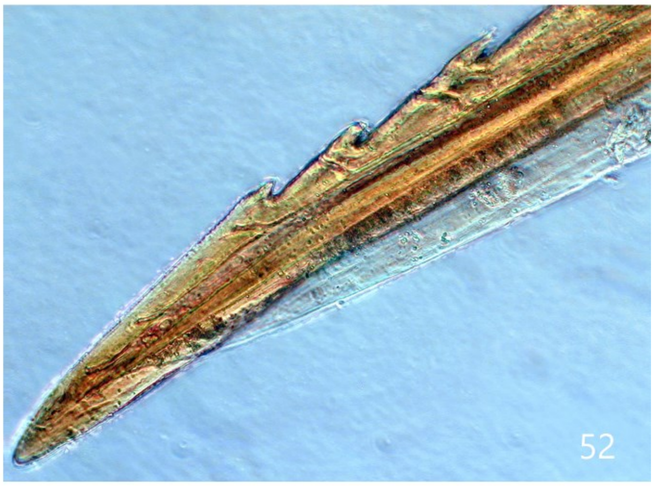


Fig. 49. Rami; a, the two curved branches (rami) of the stabbing needles or lancets that stick together in the sting sheath, 40×; left and right of the fork pieces of the square plates; b, side view of the sting sheath (as) with a needle (s) exposed and the vesicular bulge or basal bulb (b), 40×. © Michel Asperges.

Fig. 50. Oblonga; a, b, two stitching needles and view of the extended plate (oblonga), 40×. © Michel Asperges.

Fig. 51. The top of the sting needles has barbs, 40×. © Michel Asperges.

Fig. 52. Detail of the top of the sting; darkfield shot, 400×. © Michel Asperges.

Arch/arcus (Fig. 39)

Between the arolium and the centre plate or planta we find a U-shaped chitinous arc covering the top of the arolium. The long tendon of the thigh and shin muscles is connected to the centre of the arcus. This tendon causes the arcus to bend or relax, which affects the up or down action of the arolium. This is very much influenced by the action of the claws and the muscles in the shins and thighs.

Middle plate/planta

The middle plate or planta is a chitinous, hairy plate communicating with the scaly plate or unguitractor and the arch or arcus on the ventral side of the pretarsus.

Manubrium (Fig. 40)

The manubrium is a small chitinous, hairy plate on the dorsal side of the pretarsus, slightly anterior to and slightly above the arch and arolium. This plate is set with two long and three to four short hairs and is connected to the arch. When the bow is activated by the long string, the manubrium will trigger the arolium into action. We suspect that the hairs act as mechanoreceptors.

Scaly plate/unguitractor (Figs 41, 42)

To get a good look at these we need to look at the pretarsus on the underside. Under a light microscope, the unguitractor on the inside of the pretarsus appears, at first sight, to be covered with scales, hence the name scaly plate. We hypothesize that, if studied with SEM, it would be more likely to be populated with pyramidal spikes (like running shoes) just like the honeybee. Such pointed pyramidal protrusions act as anti-slip.

Shin (Figs 43–45)

The middle and hind legs show two thick spurs at the transition from the shin to the basitars that play an important role in catching and holding prey, usually a honeybee. The hind leg is clearly longer than the front and middle leg. In the resting state, we see that the wasp is tilted upwards.

Abdomen

The abdomen (Figs 46, 47), like in the honeybee, is made up of chitinous rings: on the back are the dorsal plates (tergites), and on the underside, are the abdominal plates (sternites). These plates slide in and over each other and are bonded to each other with flexible chitinous membranes. The entire abdomen is covered only with very short, thin hairs. Longer or branched hairs such as those possessed by honeybees and bumblebees are missing, as the hornet does not collect pollen. On the edge of the abdominal plates, the openings of the breathing tubes (tracheae) can be seen as small, round spots: the stigmata. All essential organs such as the heart, digestive system, excretory system, reproductive system, and parts of the nervous system, are located in the abdomen. However, we did not investigate these because our study material was no longer fresh enough.

Sting (Figs 48–52)

All females have a sting, the males have none. The sting is located on the pointed end of the abdomen. The sting chamber is formed by the dorsal (tergites) and ventral plates (sternites) of the last abdomen rings (VII to IX and X). Some of the tergites and sternites (IX and X) have been converted into three plates on which the muscles are attached: the square plate, the triangular plate, and the elongated plate or oblonga, according to Dessart (1995). More details are described by Snodgrass (1956), Dade (1962), and Goodman (2003).

According to Dade (1962) and Zi-Long Zhao *et al*. (2015), the brown part that we regard as the sting is actually the sting sheath or sheath (stylet) with a bladder-shaped bulge (basal bulb) at the top. Two lancets or stab needles (lancets) slide into the sting sheath, which is covered with very small hooks on their pointed end. Together they form the real sting. When stinging they slide out independently of each other and form a capillary tube through which the venom, accumulated in the vesicular thickening, squirts out.

The lancets are bent at the top of the sting chamber and hang together there. They form two connected twigs (rami English, rameaux French). The muscles (retractor and protractor) are fixed on the plates of the sting chamber and are innervated by an independent nerve node (no. 7) that produces the movement. The nerve knot remains active for a while after the loss of the sting, which is very exceptional in wasps. Beekeepers are familiar with this reaction after a bee sting where the sting gets stuck, and the nerve knot ensures that the sting continues to pump poison.

The Asian hornet sting is similar to the sting of other wasp species and causes a severe, burning pain that leaves a red, swollen, or unswollen spot. The after-effects of this venomous sting can last a long time and then turn into severe itching. According to Villers (2019), the sting is no longer than that of the European hornet (3 mm) and the amount of venom is no greater than that of the honeybee (15 microlitres). People who are allergic to wasp venom develop a similar allergic reaction as to other wasps and should see a doctor or emergency room as soon as possible. For the time being, no data is known about the exact composition of the Asian hornet's venom and whether it differs from that of other wasps and the European hornet.

All wasps, including the Asian hornet, can sting many times in succession, often in defence. The venom consists largely of proteinaceous substances. Quinine-like substances are responsible for the pain sensation. The venom also contains nerve toxins (neurotoxins), which break down cell tissue, quickly paralyzing captured prey. The poison works very quickly. You feel a sting from this wasp immediately and in full intensity. Almost everywhere, it is mentioned that the sting has no barbs and that the wasp can sting several times. This is not quite correct.

At first sight, the sting has no barbs, but microscopically you can still see very small hooks – too small to get stuck in human skin – at the top of the lancets.

Conclusions

Although beekeepers are right to combat this alien species of wasp, given the danger to honeybees, it remains a fascinating insect for biologists.

Many structures in the Asian hornet resemble those of the honeybee. The biting mouthparts on the head of the Asian hornet are quite complex in structure, the jaws are optimally adapted to bite and manipulate wood when building their paper nest. These wasps are mainly carnivorous except in autumn when they also eat fruit. The jaws have many thin, single hairs with an olfactory function. There are many tactile and olfactory hairs on the feelers and especially oval olfactory discs with a thick edge. The antennae of the drone are longer than those of the worker and queen. They have normal faceted and pointed eyes.

The front legs are provided with a comb at the transition between the shin and the first segment of the foot (basitars). With this comb, they clean their antennae. The middle and hind legs carry two spurs with which they hold their prey. The foot end is provided with a pair of claws with two long hairs, an arolium and a unguitractor or scaly plate, and a manubrium. The manubrium has two long and three to four short hairs. Running through the foot segments is a tendon that attaches to the arch or arcus and the muscles in the shin and thigh.

The abdomen of the drone is rather blunt; that of the worker bee is pointed. The drone has yellow spots on the tergites. All females have a sting consisting of a brown sting sheath and two thin needles or lancets with very small barbs. These wasps can sting several times without losing the sting. A sting from the Asian hornet causes the same problems in humans as any other wasp sting but is more painful.

Acknowledgments

Thanks to Staf Kamers and the Leuven fire brigade for supplying Asian hornets from Leuven. Also, a word of thanks to Roeland Vaes and Mieke Van den Wijngaert for updating the photos and making the text more understandable. Finally, a word of thanks to Ms Betty Gennez for her help in making the photos clearer and more organized.

Literature

Asperges M., Lambrichts I., D'Haenen J. & Van Belleghem F. 2020. Ruiken, voelen en tasten als communicatie. — *KVIB Maandblad van de Vlaamse Imkersbond* **106**(5): 8–15.

Baranek B., Kuba K., Bauder J. & Krenn H. W. 2018. Mouthpart dimorphism in male and female wasps of *Vespula vulgaris* and *Vespula germanica* (Vespidae, Hymenoptera) — *Deutsche Entomologische Zeitschrift* **65**(1): 65–74. https://dez.pensoft.net/article/23593/

Dade H.A. 1962.*Anatomy and dissection of the honeybee uit*. — International Bee Research Association London UK, The Zoological Society of London UK, 158 pp, 20 pls.

de Wilde A. & Haxaire J. 2011. Aziatische hoornaars — *KVIB Maandblad van de Vlaamse Imkersbond* **97**(2): 17–19.

Desmadryl D. 2017. Eerste nest van Aziatische hoornaar in Vlaanderen. — *KVIB Maandblad van de Vlaamse Imkersbond* **103**(10): 13.

Dessart P. 1995. *De Honingbij*. — KBIN Koninklijk Belgisch instituut voor Natuurwetenschappen, 174 pp.

Goodman L. 2003. *Form and function in the honey bee*. — International Bee Research Association, 220 pp.

Honeybee Valley. 2018. *De verspreiding van de Aziatische hoornaar in kaart gebracht*. — https://www.honeybeevalley.eu/newsflash/de-verspreiding-van-de-aziatische-hoornaar-in-kaart-gebracht (accessed 25 February 2023).

Schoonvaere K., Laget D., Adriaens T., Desmet P., Villers V. & de Graaf D. 2020. *Rapporten van het Instituut voor Natuur- en Bosonderzoek 2020 (39). Eindrapport in het kader van de oproep Citizen Science van het Departement Economie, Wetenschap en Innovatie (EWI) van december 2017*. — https://purews.inbo.be/ws/portalfiles/portal/19229441/Schoonvaere_etal_2020_VespaWatchInvasiemonitoringVanDeAziatischeHoornaarMetHobbyimkersEnHetPubliek.pdf

Snodgrass R. 1956. *Anatomy of the honeybee*. — Cornell University Press, Ithaca, New York and Comstock publishing associates, London, 334 pp.

Villers V. & Schoonvaere K. 2019. *Bijen en wespen een kennismaking*. — Honeybee Valley, Gent, 35 pp.

Zhao L., Zhao P., Ma J., Wu W., Yang K. & Feng Q. 2015. Structures, properties, and functions of the stings of honey bees and paper wasps: A comparative study. — *Biology Open* **4**(7), 921–928. https://doi.org/10.1242/bio.012195