

outer (3-C), and more than twice as long as the outer setae. The postclypeal setae (4-C) are of variable length, and as long as the outer clypeal setae (3-C) which extend beyond the anterior margin of the frontoclypeus (frequent character of larvae from Portugal, Greece, Turkey, Iran and Tadjikistan populations), or are short and do not surpass the margin (larvae from Spain, Algeria, Tunisia, Israel and Jordan). The frontal setae (5-C to 7-C) are plumose, with 6-7 pairs of lateral branches. The end of the inner frontal seta (5-C) hardly reaches the base of the postclypeal seta (4-C). The prothoracal seta 1-P is well developed, with a strong shaft, pinnately branched, similar to 2-P and 4-P. Seta 3-P is single, rarely 2-branched. Seta 1-T on the metathorax of palmate type, with 10-11 leaflets. The abdominal seta 1-I is short and spine-like. The palmate setae 1-II to 1-VII are well developed, with 15-19 leaflets, sometimes more. The leaflets are narrowed in 2-3 irregular steps beyond the middle, forming a filament that is at least 1/3 as long as the blade (Fig. 8.12a). The antepalmate setae on abdominal segments IV and V (2-IV and 2-V) are single, rarely with 2 branches. The abdominal setae 6-I to 6-III are pinnately branched.

Biology: *An. marteri* is a polycyclic species often found in mountainous regions. In Sardinia and Corsica, the species was collected from sea level up to 1,000 m (Aitken 1954a), and in Tadjikistan from 900 to 1,600 m (Keshishian 1938). Females hibernate in natural shelters. Spring is the preferred season for larval development but a second, autumnal peak has been registered as well (Logan 1953; Senevet and Andarelli 1956). Larvae have been found from March-September in shaded, clear and cool water in rock pools and mountain streams and springs, with rocky bottom and scarce vegetation. They usually breed in acidic water (pH 5.5-6.0) within a temperature range of 15-22°C (Senevet and Andarelli 1956; Ribeiro et al. 1987). The larvae can be found in association with those of *An. atroparvus*, *An. claviger* s.s., *An. petragani*, *Cx. p. pipiens* and *Cx. territans* (Gutsevich et al. 1974; Ribeiro et al. 1987). *An. marteri* females are sylvatic, exophagic and markedly zoophilic.

Distribution: It is a southern Palaearctic species, which is distributed from Portugal and North Morocco to Tadjikistan. In Europe it is recorded in Albania, Bulgaria, Corsica, Greece, Portugal, Sardinia, Sicily, and Spain.

Medical importance: According to its strong preference for animal hosts, *An. marteri* is most probably of minor importance as a vector of human diseases (Ribeiro et al. 1988).

Notes on systematics: Since 1927 when Senevet and Prunelle described *An. marteri* as a new species, the closely related *An. sogdianus* was described in Tadjikistan (Keshishian 1938) and *An. marteri* var. *conquensis* in Spain (Torres Canamares 1946). Later, *An. sogdianus* was given subspecific status under *An. marteri* after Beklemishev (in Boyd 1949). Ribeiro et al. (1987) stated that *An. marteri* is a polymorphic, monotypic species, and that the names *sogdianus* and *conquensis* were only the morphs that have to be treated as junior synonyms of *marteri*. The authors hypothesize that the clinical distributions of the morphs is temperature dependent, with a January isotherm of +10°C separating *marteri/conquensis* in the south from *sogdianus* in the north. The proposed status was accepted by Ward (1992).

***Anopheles (Anopheles) plumbeus* Stephens 1828**

Female: *An. plumbeus* can be distinguished from the similar *An. claviger* by its smaller size and its general darker, leaden colouration. The pleurites of the thorax and the lateral parts of the scutum are blackish brown, forming a distinct contrast to the pale or ashy-grey median part of the scutum. Furthermore, the wings are more densely scaled and darker in appearance than those of *An. claviger*. The proboscis and palps are black, with the palps being approximately the same length as the proboscis with the apical segment more than half as long as the penultimate one. The pedicel is brown, and the flagellum is blackish brown with black setae. The vertex has a tuft of narrow, pure white scales, which is directed anteriorly, and yellowish longer setae. The occiput is covered in its median part with whitish lanceolate and erect forked scales, laterally with black erect forked scales. Lateral parts of the scutum are blackish brown, with a median longitudinal grey stripe which covers at least 1/3 of the width of the scutum. The anterior margin of the scutum has a well developed anteachrostichal tuft of pure white, narrow scales (Fig. 6.12a). The scutellum is brown with dark setae, its posterior margin is slightly concave at the sides, and the postnotum is dark brown. The pleurites

are blackish brown with 5-6 prespiracular setae. The legs are black or blackish brown, the coxae and ventral surfaces of the tibiae are slightly paler. The wings are densely covered with dark brown, lanceolate scales and not spotted; the cross veins are well separated. The abdomen is black, and covered with pale brown or dark setae with a golden tinge.

Male (Fig. 9.7): The gonocoxite bears 2 two strong parbasal setae of approximately the same length. They arise directly from the surface of the gonocoxite, not from a tubercle. The internal setae are inserted near the middle of the gonocoxite. The apical spine of the gonostylus is short. The claspettes are divided into two lobes, the outer lobe bears three setae, which might be slightly flattened and situated close together but are not fused. The inner lobe bears one short hair-like seta and two to three spine-like setae of variable length, at least one of which is slightly bent at the apex. The aedeagus is short and broad, without spines or leaflets.

Larva: Larvae of *An. plumbeus* are at once distinguished from all other European species of the genus *Anopheles* by the frontal setae (5-C to 7-C) which are reduced in size and are single (Fig. 8.7b). The head is more or less oval, uniformly dark brown, and the primordial compound eyes are weakly developed. The antennae are approximately 1/3 of the length of the head, straight and smooth. The antennal seta (1-A) is very short and single, situated close to the base. The clypeal setae (2-C and 3-C) are thin and sparsely

branched. The distance between the pair of inner clypeal setae (2-C) is smaller or almost the same as the distance between the inner (2-C) and outer clypeal setae (3-C). The postclypeal setae (4-C) are short and single, and situated wide apart. The distance between them is larger than the distance between the outer clypeal setae (3-C). Seta 1 of abdominal segment I (1-I) is short and single. The palmate setae on abdominal segments II-VI (1-II to 1-VI) are conspicuous, but inconspicuous or rudimentary on segment VII. Each palmate seta consists of 14-15 lanceolate leaflets with a pointed apex, but without a terminal filament, their margin may be slightly serrated in the apical half. The lateral setae on segments I-VI (6-I to 6-VI) are large and pinnately branched. Each abdominal segment ventrally carries two pairs of stellate setae. The pecten plate is usually composed of teeth of more or less the same length. The saddle is covered with numerous spicules. The ventral brush has 17-19 fan-like setae arising from a common base. The anal papillae are shorter than the saddle.

Biology: Larvae of *An. plumbeus* develop almost exclusively in tree-holes. The breeding water is usually dark brown owing to the dissolved tannins and pigments derived from the wood and has a high concentration of salts in combination with a deficiency of oxygen (Mohrig 1969). The larvae are ordinarily found in tree-holes in beech (*Fagus sylvatica*), ash (*Fraxinus excelsior*), elm (*Ulmus* sp.), sycamore (*Acer pseudoplatanus*), lime (*Tilia* sp.), oak (*Quercus* sp.), birch (*Betula* sp.), horsechestnut (*Aesculus hippocastanum*) and others, often together with larvae of *Oc. geniculatus*. Further associates may be larvae of *Or. pulcripalpis*, *Oc. berlandi*, *Oc. Echinus*, and *Oc. pulcritarsis*. The eggs of *An. plumbeus* are not laid on the water surface but on the side of the tree-hole and hatching occurs when the hole is flooded. Thus, the number of generations per year depends on the hydrological situation. Hibernation takes place in the egg or larval stage. The larvae which hatch in autumn usually grow into the second and third-instar by the end of the year, but do not pupate until the next spring. They spend most of the time at the bottom of the hole and can survive long periods when the water surface is frozen, but high mortality can be observed when the breeding water and the mud at the bottom are entirely frozen during a long period (Mohrig 1969). In spring, a major proportion of the larvae hatch from hibernated eggs. Occasionally, especially in periods of drought, larvae of *An. plumbeus* may also occur in artificial containers, rock holes, or in ground depressions in shaded situations

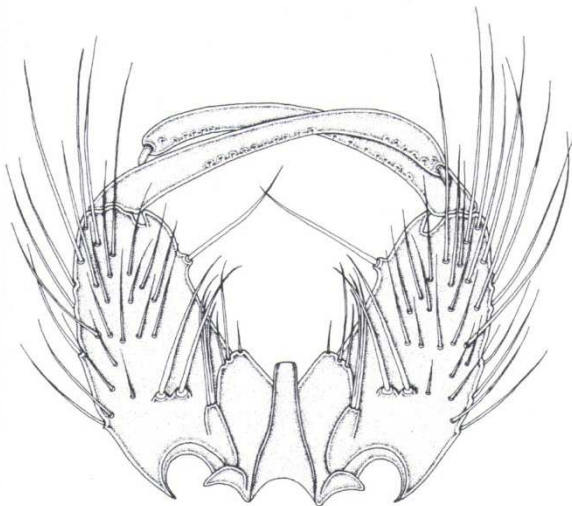


Fig. 9.7 Hypopygium of *An. plumbeus*

containing a rich infusion of fallen leaves (Aitken 1954a). In central Europe the adults usually occur from late spring on and are present until the end of September. They can be found from sea level up to an altitude of 1,200 m (Senevet and Andarelli 1956), and in the southern part of its range the species occurs in forests and in mountainous areas up to altitudes of 1,600–2,000 m (Gutsevich et al. 1974). Females are persistent biters and they are most active during the crepuscular period, feeding principally on mammalian blood, including that of humans (Service 1971a). Occasionally they have been observed to attack humans during the day in shaded situations along forest edges. Some populations have shown a strong anthropophilic preference (Petric 1989). Because of its preferred larval habitats, *An. plumbeus* is mainly found in forests and rural areas, but considerable populations may also be found in urban situations, where the larvae develop in tree-holes in gardens or parks. However, it has adapted its breeding habit to widely available artificial breeding sites below the ground, such as catch basins and septic tanks with water contaminated with organic waste. Therefore, in central Europe *An. plumbeus* has increased in numbers during the last decades and can be a major nuisance species in human dwellings especially when unused septic tanks support mass breeding.

Distribution: *An. plumbeus* is widely distributed throughout Europe wherever there are deciduous trees in which rot holes can be found. It is also distributed in the northern Caucasus, in the Middle East south to Iran and Iraq and in North Africa. A similar species which is found in India and Pakistan is considered by most experts to be the species *An. barianensis* James, but Gutsevich et al. (1974) pointed out that there are no distinct differences between *An. plumbeus* and *An. barianensis*. In North America, *An. plumbeus* is replaced by an allied species, *An. barberi* Coquillett, which closely resembles it (Marshall 1938).

Medical importance: Although laboratory studies have shown that *An. plumbeus* can successfully be infected with *P. vivax* and *P. falciparum* (Weyer 1939; Marchant et al. 1998) and that the species is an efficient carrier of malaria, it is considered to be of minor epidemiological importance at the present time because of its ecology. In the past, *An. plumbeus* played a major role as a vector in forests in Caucasian resorts (Gutsevich et al. 1974) and probably has been responsible for two recorded cases of locally transmitted malaria in London, UK (Shute 1954).

9.1.2 Subgenus *Cellia* Theobald

Members of this subgenus are characterized as follows: In the adults, the costa (C) has four or more pale spots and the cross vein areas and furcations of R_{2+3} and M are pale scaled. In males the base of the gonocoxite bears 4–7, usually 6, parbasal setae, situated close together and not arising from distinct tubercles. The internal seta is absent. The larvae of the subgenus *Cellia* have a single and small antennal seta (1-A) which is situated on the outer side of the antennal shaft. The inner clypeal setae (2-C) are wide apart, situated closer to the outer clypeal setae (3-C) than to each other. The leaflets of the palmate setae are not lanceolate, but always abruptly narrowed or shouldered, thus divided into a blade and a terminal filament. The subgenus *Cellia* is mainly distributed in the Oriental and Ethiopian regions and is not found in the Nearctic. In Europe, the distribution range of the subgenus is confined to the Mediterranean region, where three species and one subspecies of *An. cinereus* can be found. Therefore, *An. cinereus* is described here, despite the complicated situation of its real distribution.

Anopheles (Cellia) cinereus Theobald 1901

Female: The proboscis and palps are extraordinarily long and slender. The palps commonly have four pale rings. The basal three rings are broad, subequal, and extend to both segments at the articulations of palpomeres II–III, III–IV and IV–V. The distalmost ring is often very narrow, sometimes indistinct or absent. When present and well developed, it occupies the apical third of palpomere V. Palpomeres IV and V are long and when combined, distinctly longer than palpomere III. Glick (1992) described the palps of *An. cinereus* as having three rings and a dark apex which is usually true for *ssp. hispaniola*. The first flagellomere is speckled with white scales. The occiput has a well developed tuft of white scales. The scutum has a median stripe of long, usually narrow pale scales, and the submedian and lateral areas are devoid of scales. The femora and tibia are dark with distinct pale spots on the femorotibial and tibiotarsal articulations. The fore and mid tarsi are entirely dark or have very narrow pale apical rings, but usually only on tarsomere I. The hind tarsi have very