

Contribution to the distribution of European mosquitoes (Diptera: Culicidae): four new country records from northern Greece

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Abstract

A study of the mosquito fauna in northern Greece yielded four species not previously recorded in the country. These are *Ochlerotatus sticticus* from the Axios River, and *Ochlerotatus pullatus*, *Ochlerotatus punctor* and *Ochlerotatus cataphylla* from the Rhodope Mountains. An uncertain record of *Ochlerotatus communis* is confirmed. Details of the records together with data on the bionomics of the species are presented.

Introduction

Most early entomological studies on the Culicidae of Greece were concerned with those mosquitoes affecting human health. Malaria was widespread in the western part of the country (Waterston, 1918, 1922) and the largest dengue epidemic in Greece occurred in 1927-28 involved more than one million cases and 1500 deaths (Cardamatis, 1929). The most complete list of species covering the whole of Greece was published by Pandazis (1935), who listed 38 species in seven genera. Later, several authors contributed to the knowledge of the mosquito species native to Macedonia and western Thrace (Eichler, 1944; Weyer, 1942; Peus, 1954). After reviewing the literature and studying the mosquito collections of the country, Samanidou-Voyadjoglou & Darsie (1993a, b) published an annotated checklist of the mosquitoes of Greece. Fifty-three species were listed, including four from old records (Pandazis, 1935), and nine unrecorded species that the authors considered should occur in Greece, based on known distribution in the literature. Consequently, the same authors presented an identification key of the mosquitoes of Greece (Darsie & Samanidou-Voyadjoglou, 1997) including all 53 species. In the recently published distribution chart of European mosquitoes, Snow & Ramsdale (1999) listed 42 species as endemic in the country with *Aedes aegypti* (Linnaeus) ranked as extinct and *Ochlerotatus communis* (De Geer) as an uncertain record.

Study area and survey results

The River Vardar, with a total length of 368 km, and the largest river of the Republic of Macedonia, becomes known as the River Axios when it enters Greece. Rising southwest of Skopje, it flows southwards through mostly treeless hilly country. The large fertile plains in the upper course of the river are under intensive agricultural use (cotton, tobacco).

The Axios enters Greece approximately 90 km from its mouth and crosses the alluvial plain west of Thessaloniki. (40°36'-40°58'N, 22° 35'-22°42'E) created by the Axios itself together with the Aliakmon, Loudias and Gallikos rivers.

The Axios finally flows into the Mediterranean Sea west of Thessaloniki bay through a delta zone encompassing brackish lagoons, saltflats, extended mudflats, islets of riverine forest, pastures and extended zones with tamarisk stands (*Tamarix* sp.). There are significant heron, wader and tern colonies in the area. These include species such as the Little Bittern (*Ixobrychus minutus*), the Night Heron (*Nycticorax nycticorax*), the Squacco Heron (*Ardeola ralloides*), the Purple Heron (*Ardea purpurea*), the Little Egret (*Egretta garzetta*), the Great White Egret (*Egretta alba*), the Common Tern (*Sterna hirundo*), the Little Tern (*Sterna albifrons*), and the Glossy Ibis (*Plegadis falcinellus*).

There are many dams on the Axios River, used principally for flood control and production of hydroelectric power. The main dam, approximately 40 km before the mouth of the river, is used to supply an extensive irrigation system with water. Thousands of hectares in the alluvial plain are used for rice cultivation. Numerous semi-permanent and permanent aquatic habitats in the rice fields and irrigation and drainage systems offer excellent conditions for mosquito development. Consequently the inhabitants of the surrounding villages suffer a periodical but long-lasting mosquito nuisance from May until the end of August.

Ochlerotatus caspius s.l. (Pallas) is the predominant species in the area during the months of May and June, when larvae are found in nearly every type of larval site. From July on, *Oc. caspius* s.l. is superseded as the main nuisance by *Anopheles hyrcanus* s.l. (Pallas). The larvae are mainly found in rice fields, associated with those of *An. sacharovi* Favre and *Culex modestus* Ficalbi. The latter two species are not as numerous as *An. hyrcanus* s.l., but play an important role in creating a nuisance in the months of July and August.

Some residual floodplain remains upstream of the main irrigation dam on the Axios River. This includes small reed beds, where larvae of both *Aedes vexans* (Meigen) and *Oc. sticticus* (Meigen) are found. Larvae were collected in flooded ditches and depressions at the beginning of May, when adults of both species were also regularly caught in human bait collections. Females of *Oc. sticticus* are easily identified by the characteristic abdominal scaling pattern, in which the pale basal bands are distinctly constricted medially on terga II-IV and completely interrupted on the more distal terga, where they take the form of pale lateral triangular patches. An additional diagnostic character on the thorax is the mesepimeral scale patch, which ends distinctly above the lower margin of the mesepimeron. *Oc. sticticus* is certainly a member of the endemic mosquito fauna along the flood plains of the Axios River. It is not as numerous as the other floodwater mosquito *Ae. vexans*, or the most predominant species in the area, *Oc. caspius* s.l., *An. hyrcanus* s.l., *An. sacharovi* and *Cx. modestus*, but was regularly collected in the larval and adult female stages.

Other mosquito species encountered in the area were *Oc. detritus* (Haliday), *Oc. geniculatus* (Olivier), *Coquillettidia richiardii* (Ficalbi), *Cx. pipiens* Linnaeus, *Cx. theileri* Theobald, *Cx. territans* Walker, *Culiseta annulata* (Schrank) and *Uranotaenia unguiculata* Edwards.

The Rhodope (Rodopi) Mountains, a part of the Balkan ranges, are located mainly in south-west Bulgaria, but also extend into east Macedonia and north-east Greece. Within a maximum distance of 240 km in an east-west direction and 70 km in north-south direction they cover an area of approximately 15000 km². The maximum elevation of 2925 m is the peak of Musala in Bulgaria. This ancient massif forms an important climatic barrier, protecting the Aegean lowlands from cold northerly winds and hindering or diverting warm southerly winds blowing onto the Thracian plain. The mountains, which are forested and contain many lakes and narrow river valleys, sustain a small tourist industry. In addition there are important hydroelectric power plants throughout the region. Extensive hardwood and coniferous forests on the lower slopes support the timber industry.

The southern part of the Rhodope Mountains are in Greece and are composed of sharp edged and frequently sloping plateaux, often rising to more than 1800 m and reaching 2212 m at Mt. Orvilos. The mountains are sparsely populated with only scattered settlements. Human activities include agriculture, cattle-raising and hunting. It has a very rich avian fauna, with breeding of raptorial species such as the Egyptian Vulture (*Neophron percnopterus*), the Griffon Vulture (*Gyps fulvus*), the Short-toed Eagle (*Circaetus gallicus*), the Golden Eagle (*Aquila chrysaetos*), and the Booted Eagle (*Hieraetus pennatus*). Other breeding species are the Black Stork (*Ciconia nigra*), the Eagle Owl (*Bubo bubo*), and various Piciformes, including the Grey-headed Woodpecker (*Picus canus*), the Black Woodpecker (*Dryocopus martius*), the Middle Spotted Woodpecker (*Dendrocopos medius*), the White-backed Woodpecker (*Dendrocopos leucotos*), and the Three-toed Woodpecker (*Picoides tridactylus*).

During mosquito surveys carried out in May 1996 and June 1997 on the southern (Greek) slopes of the Rhodope Mountains (41°07'–41°34' N, 24°20'–24°51' E), all detected potential aquatic habitats were sampled for larvae and pupae. Most specimens were preserved in alcohol for slide preparations, but some individuals were allowed to emerge to obtain adults of both sexes. Larvae of *Oc. pullatus* (Coquillett), *Oc. cataphylla* (Dyar), *Oc. punctor* (Kirby) and *Oc. communis* were found. The first three species are new records for Greece and the hitherto uncertain record of *Oc. communis* (Cardamatis, 1931) is confirmed.

Fourth instar larvae of *Oc. pullatus* were encountered at an altitude of approximately 1300 m in a small pool (surface area: 2.5 m²; max. depth: 20-30 cm) created after heavy rainfall and located close to a minor forest road. The water was clear and devoid of submerged vegetation, but with a thick layer of dead leaves and mud at the bottom. Water temperature ranged between 6.2°C and 7.5°C, with a pH value of 6.6, and a conductivity of 100 µS. No other species were found at this site.

Ochlerotatus pullatus females have a characteristic mesonotal pattern of scaling. The scutum is clothed with narrow yellowish brown scales, separated by longitudinal stripes exposing the dark integument, each of which is bordered by longitudinal stripes of brown scales. The scutoscutellar suture, prescutellar area and lateral margins of the scutum are also dark and devoid of scales. The hypostigmal scale patch is present, but

postprocoxal scales are absent, characteristics shared only with *Oc. intrudens* (Dyar). However, in contrast to the latter species, the scale patch of the mesepimeron reaches the lower margin of the sclerite and lower mesepimeral setae are present. The gonocoxite of the male genitalia carries a well-developed thumb-like apicodorsal lobe and a basal dorsomesal lobe with three differentiated setae (characters separating the *intrudens* Section from other species of the subgenus *Ochlerotatus*). In *Oc. pullatus* the basally inserted seta is long, stout and apically curved, and the two ventrally inserted setae are unequal, one long and spine-like, the other tending to be flattened and lance-like.

The larva possesses more than 40 comb scales, a character shared with *Oc. communis* and *Oc. pionips* (Dyar)*. However, setae 5-C and 6-C of *Oc. pullatus* are branched, all having at least 3 well-developed aciculate branches (mostly 4-6). In *Oc. communis* these are single, occasionally double, setae. The lateral comb scales of *Oc. pullatus* are more or less pointed, which separates the larvae from those of *Oc. pionips** in which the comb scales are fringed with subequal denticles.

Ochlerotatus pullatus is a northern Holarctic species with a disjunct distribution. In the northern parts of its range larvae can be found in small clear snowmelt pools in the arctic tundra and in the lowlands and plains of Eurasia and North America. In central and southern Europe the species is restricted to mountainous regions up to very high elevations (2000 m and higher). The larvae can be found in a variety of breeding sites e.g. in puddles and pools devoid of vegetation and created by overflow of mountain streams or heavy rain, and in small clear lakes with a rocky bottom or boggy marginal holes. Females readily attack their hosts during any time of the day in forested areas. The species is usually found in small numbers, but adults can be abundant in some localities, generally remote from human habitations (Carpenter & LaCasse, 1955).

According to the known distribution of *Oc. pullatus* in Europe (Dahl & White, 1978; Snow & Ramsdale, 1999), the collected specimens from the Rhodope Mountains represent the continent's southernmost record.

Third and fourth instar larvae of *Oc. cataphylla* were collected at an altitude of approximately 1150 m in an inundated meadow close to a small spring, the source of a mountain brook in a mainly coniferous (*Picea* sp.) forest, but also with scattered beeches (*Fagus* sp.) and birches (*Betula* sp.). The larvae were associated with second to fourth instar larvae of *Oc. punctor* and *Oc. communis*. The whole terrain embraced 0.25 ha, and the temperature of the water ranged between 6.5°C and 7.7°C, with a pH of 6.8, and a conductivity of 250 µS. The water in these breeding sites was clear, over a grassy bottom and with submerged vegetation.

Adults of *Oc. cataphylla* have wing veins with intermixed pale and dark scales, especially along the costa, subcosta and radius. The proboscis is uniformly dark scaled, a character which separates the species from *Oc. leucomelas* (Meigen). Larvae are easily identified by the characteristic pecten, in which the 2-4 distal most pecten teeth are distinctly larger and more widely and irregularly spaced than the others. All detached pecten teeth are located beyond the insertion point of seta 1-S. Setae 5-C and 6-C are single, two characters distinguishing *Oc. cataphylla* from the morphologically similar *Oc. intrudens*.

Ochlerotatus cataphylla has a Holarctic distribution. In northern Europe the species occurs in tundra, in central Europe it is found in swampy forests, and in southern Europe it is mainly restricted to mountainous areas. It is a monocyclic species, typically developing in pools in swampy woodlands e.g. alder forests. Larvae hatch immediately after the thaw, when melt water or heavy rainfall floods depressions. *Ochlerotatus cataphylla* females are usually a nuisance only in forest areas, where they bite even during daytime, and where repeated blood meals make frequent oviposition possible (Carpenter & Nielsen, 1965).

Females of *Oc. punctor* differ from those of *Oc. communis* in the presence of postprocoxal scales and in the abdominal scaling pattern, in which the pale basal tergal bands on at least the more distal segments are distinctly constricted medially. The larvae are readily distinguished from all other southern European *Ochlerotatus* species by the saddle, which completely encircles the anal segment**. The comb of *Oc. punctor* consists of 10-25 small scales, each usually shorter than the distal three pecten teeth.

- and *Oc. detritus* though this species is not found in mountain habitats ** the far northern sibling species *Oc. hexodontus* (Dyar) and the arctic *Oc. nigripes* (Zetterstedt) also have a saddle completely ringing the anal segment. That of *Ae. punctodes* (Dyar) almost, but not completely encircles the segment. Seta 1-A has 1-3 branches in *Oc. nigripes*, 4-7 branches in *Oc. punctor* and is multibranching in *Oc. hexodontus*. The chances of finding *Oc. nigripes* or *Oc. punctodes* so far south are minute; *Oc. hexodontus* occurs as far south as California, Colorado and Japan.

Ochlerotatus punctor is widely distributed in the northern parts of the Holarctic region, but is more restricted towards the south. It is a typical snow melt mosquito, with a predilection for swampy forests with boggy waters. The larvae hatch during the snow melt, when the water temperature is only a little above 0°C. Larvae of this acidophilic species preferably inhabit waters with a considerable acidity, and are numerous in boggy waters with growths of *Sphagnum* sp., where the pH value can be less than 4.0. The adults prefer covered terrain and seldom migrate out of the forest. Their peak biting activity is crepuscular, but on sultry days and in strongly shaded situations they can be troublesome even during daytime.

The females of *Oc. communis* are characterised by the absence of postprocoxal and hypostigmal scales, the presence of a mesepisternal scale patch reaching the anterior angle of the mesepisternum, and a mesepimeral patch of pale scales reaching the lower margin of the mesepimeron. The abdominal terga are dark scaled with broad pale basal bands of more or less uniform width. In the male genitalia the upper part of the basal mesodorsal lobe carries a row of long, prominent, widely spaced setae that are strongly curved or sometimes hooked apically. The larval comb is composed of more than 40 scales, a character shared with *Oc. pullatus*, (and *Oc. detritus*), but setae 5-C and 6-C are single, or rarely one pair has two branches.

Ochlerotatus communis has a predominantly northern or highland Holarctic distribution. It is usually a univoltine snowmelt mosquito, frequenting swampy forests. The preferred larval sites are acidic water bodies in hollows inundated by rising water tables or run off during the snow melt or spring rainfall. In much of Europe larvae typically hatch when the breeding sites are still partly covered with ice. In Central Europe females are troublesome for warm-blooded creatures in forest areas, particularly during the twilight periods. Females do not migrate far from the breeding sites.

Pinned females and males, slide preparations of male genitalia, fourth instar larvae and pupal exuviae of the new country records are deposited in the mosquito collections of KABS, Waldsee, Germany and the National School of Public Health, Athens, Greece.

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