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The first fossil caddisfly (Insecta: Trichoptera: Phryganeidae) of Anatolia, from the locality of Vitala of the Early Miocene of Kymi (Evia, Greece) and it's palaeogeographic importance

ANTONIOS ISIDOROS AVRITHIS[1, 2]
[1]*The Open University, School of Environment, Earth and Ecosystem Sciences, Walton Hall, Kents Hill, Milton Keynes MK7 6AA, United Kingdom*
[2]*Friedrich Alexander University, Department of Paleontology, Henkestraße 91, 91052 Erlangen, Germany*
tonyavrithis@gmail.com; *https://orcid.org/0000-0001-7813-5843*

The fossil record of insects in Greece is particularly scarce, with the only known locations comprising Evia (Bachmayer *et al*., 1971, 1981) and Crete (Wappler *et al*., 2009), each with a very small number of specimens. However, the fidelity of certain insect orders prevents their preservation in certain settings that other orders may be represented. The order Trichoptera is scarcely represented in the fossil record compared to Diptera, Coleoptera and Hymenoptera which are more abundant in Cenozoic (Labandeira & Sepkoski, 1993). Additionally, larval cases of Trichoptera are more commonly preserved than body fossils. In this paper, I describe a new specimen belonging to Phryganeidae from the Vitala area of Kymi, a rare family for compressional fossil findings, based on a fossilized wing. Furthermore, this is the first record of a fossil trichopteran from the Early Miocene Anatolian landmass, an understudied palaeogeographic area for palaeoentomology.

The Vitala deposit (Fig. 1) is located in a former open-pit limestone mine, in Kymi municipality, Evia Island, central Greece and is part of Aliveri-Kymi Basin. Stratigraphically, the deposit is found in the lower part of Aliveri-Kymi Formation. In particular, this formation has yielded hundreds of fossil plant specimens from all stratigraphic levels although the attribution to exact strata or sequences isn't precisely described (Velitzelos *et al*., 2014). A distinct lignite layer is present between the upper and the lower parts of the formation. Previous researchers have indicated that the subbasin indicated in Fig. 2 (A) forms a syncline with the northeastern and southwestern margins corresponding to the oldest strata of the formation. In this way, the Vitala locality, in the northeastern margin of the subbasin is considered as the older part of the Miocene strata. The exact age of the formation is not known. For the younger strata, the lowest age limit for the Kymi marl sequence is 13 Ma, marked by dated volcanic rocks (Fytikas *et al*., 1976).

Material and methods. The specimen is deposited in the collections of Athens Museum of Paleontology and Geology of the National and Kapodistrian University of Athens. The specimen was photographed with the use of a Nikon D3400 camera with AF-S Micro NIKKOR 40mm lens mounted. The wing venation sketch was made using Adobe Illustrator CS6 software. Taxonomy follows Holzenthal *et al*. (2011) and venation nomenclature follows Sukatsheva (2016).

FIGURE 1. The abandoned Vitala open-pit mine.

FIGURE 2. Satellite image of the greater area of Kymi, with the two Neogene sub-basins (A, B) and the locality of Vitala indicated by a red star.

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Order Trichoptera Kirby, 1813
Family Phryganeidae Burmeister, 1839
Genus *Phryganea* Linnaeus, 1758

Description. The specimen is represented by a nearly complete left forewing with some basal and marginal parts not being preserved (Fig. 3). The size of the wing is approximately 12 mm and the venation exhibits characters typical of the Phryganeidae family. Subcostal veins run parallel to costal and end near the apex and the costal field is much wider than postcostal one. The R1 apex is extremely curved, a diagnostic feature of the genus *Phryganea* and close to the subcostal vein on its apex. The discal cell does not look close in the fossil, but its speculated position indicates a much-elongated cell, characteristic of the genus *Phryganea*. R3, R4 form the longest fork (fork I) that has a pointed base and branches distally behind the discoidal cell. Fork II is virtually absent, because R4-R5 crossvein has not been preserved. Fork III is very short petiolate. Fork IV is as long as its stem. Fork IV is usually observed in females of this genus. M-Cu crossvein is present, bent, touching the base of fork V. A2 curved and touches A1 at midpoint. Crossveins s and r not visible.

Discussion. The specimen represents a new occurrence on the fossil record of Trichoptera, with such records having been particularly rare in the Miocene. The stratigraphic origin of this particular find is unfortunately lost as it was found ex-situ, although the rock characteristics are indicative of its origin. In the broader area of Kymi, three marl formations / facies can be observed, a lowermost marly formation, an intermediate dark marly formation with lignite and an upper yellowish finely bedded marl formation (Velitzelos, 2002). To the older extent, a range of Middle to Early Miocene is possible, fitting the paleobotanical interpretations (Velitzelos, 2002; Velitzelos *et al*., 2014). According to Velitzelos (2002), the uppermost yellowish marl layer has yielded most of the plant fossils and the previous insect material. However, the basal (first) part / facies have a distinct flora composition with *Fagus* sp. present. The flora composition of this part of the formation is similar to the findings that the collector who donated the specimen has found in his blocks. The youngest age limit for the Kymi marl succession is 13 Ma (Fytikas *et al*., 1976) although the floral composition is considered as characteristic of Early Miocene (Velitzelos, 2002). The paleoenvironment of Kymi during Early Miocene has been reconstructed as consisting of broad-leaved nothophyllous to microphyllous evergreen forest in a subtropical climate (Velitzelos, 2002; Velitzelos *et al*., 2014). Kymi, during the Early Miocene, was part of the Anatolian landmass, as palaeogeographic studies indicate (Roegl, 1999; Harzhauser & Piller, 2007).

Phryganeidae are found in the fossil record from Eocene to Miocene. *Phryganea* occurrence is represented by multiple species of amber specimens. Multiple species are recorded from

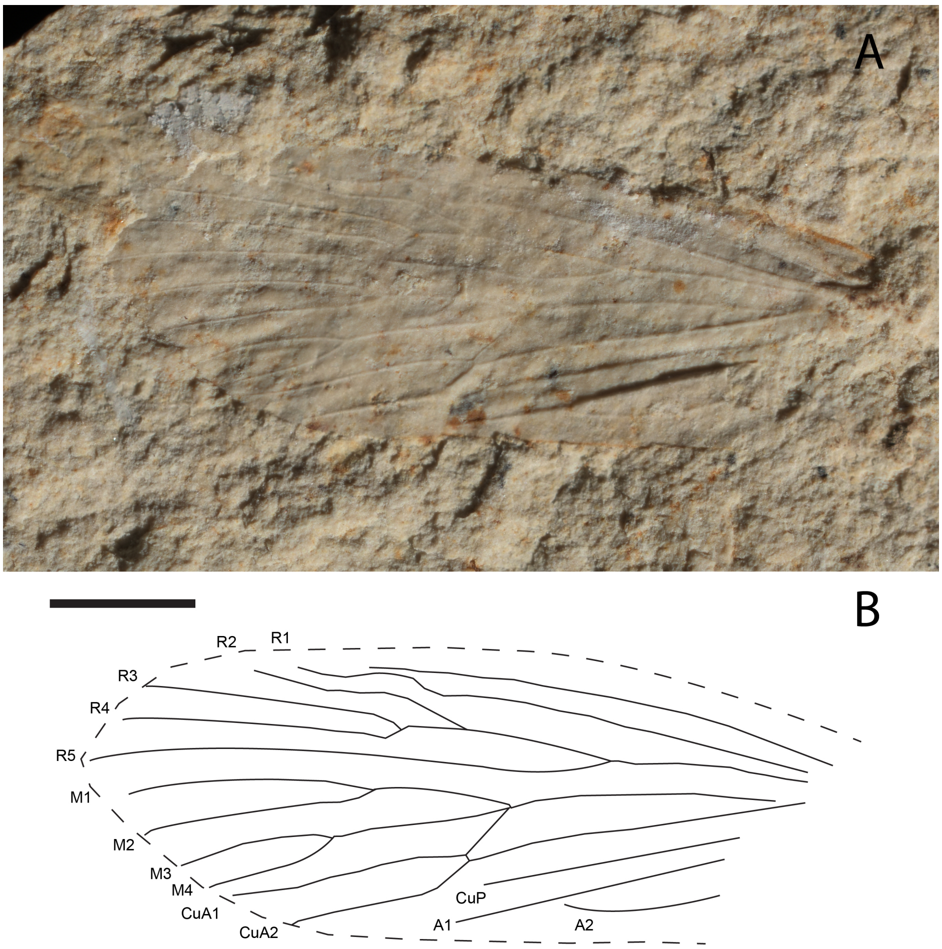

FIGURE 3. A, The described compressional fossil. **B**, Line drawing of the forewing venation of the specimen. Scale bar: 2 mm.

TABLE 1. List of Cenozoic compressional fossils of *Phryganea* (after Sukatsheva, 2016).

Locality	Age	Species	Reference
Lleida, Spain	Upper Miocene	*Phryganea* sp.	Arillo & Bremond, 1992
Washington, USA	Upper Miocene	*Phryganea spokanensis* Carpenter, 1931	Carpenter, 1931
Parschlug, Austria	Upper Miocene	*Phryganea parschlugiana*	Heer, 1883
Mombach, Germany	Lower Miocene	*Phryganea mombachiana* Hoenninghaus, 1844	Sukatsheva, 2016
Aix en Provence, France	Upper Oligocene	*Phryganea ulmeri* Meunier, 1918	Meunier, 1918
Rott, Germany	Upper Oligocene	*Phryganea lithophila* Statz, 1936	Statz, 1936
Rott, Germany	Upper Oligocene	*Phryganea elegantula* Meunier, 1919	Meunier, 1919
Amgu (= Granatnaya River), Russia	Lower Oligocene–Upper Eocene	*Phryganea lavrushini* Cockerell, 1925	Cockerell, 1925
Florissant, USA	Upper Eocene	*Phryganea wickhami* Cockerell, 1914	Cockerell, 1914
Florissant, USA	Upper Eocene	*Phryganea miocenica* Cockerell, 1913	Cockerell, 1913
Florissant, USA	Upper Eocene	*Phryganea labefacta* Scudder, 1890	Scudder, 1890
Menat, France	Paleocene (Danian)	*Phryganea nigripennis* Piton, 1940	Piton, 1940
Greenland	Paleocene (Danian)	*Phryganea hyperborea* Heer, 1883	Heer, 1883

Eocene Baltic amber (Wichard, 2013; Ivanov *et al*., 2016) and a single species from Rovno amber deposits (Melnitsky *et al*., 2024). All other known species are found as compressional fossils and are summarized in Table 1.

The expanded range of the family during the Neogene is observed today in extant species, although Southern European territories must have acted as refugia at glacial periods as for several other animals (Sommer & Zachos, 2009). However, the modern ecology of Phryganeidae shows them having a preference to more temperate than tropical-subtropical climates and this cannot be fully understood.

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