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Mayflies from Israel (Insecta; Ephemeroptera) I.- Heptageniidae, Ephemerellidae, Leptophlebiidae & Palingeniidae*

by

Michel SARTORI[1]

With 45 figures

ABSTRACT

This paper is the first part of a work dealing with the mayfly fauna of Israel. Eleven species are reported here. The most diversified family is the Heptageniidae with six species belonging to six different genera: *Rhithrogena znojkoi* (Tshernova), *Epeorus zaitzevi* Tshernova, *Ecdyonurus asiaeminoris* Demoulin, *Electrogena galileae* (Demoulin) (comb. nov.), *Afronurus kugleri* Demoulin and *Heptagenia samochai* (Demoulin) (comb. nov.). *E. zaitzevi* is new for the fauna of Israel. The male of *H. samochai* is described for the first time and the synonymy with *H. lutea* Kluge (syn. nov.) is proposed. Eggs of the six species are described and illustrated. Keys are provided for nymphs and adults. Ephemerellidae are represented by a single species, *Ephemerella mesoleuca* (Brauer). Leptophlebiid species are: *Paraleptophlebia submarginata* (Stephens), *Choroterpes (Ch.) picteti* Eaton and *Choroterpes (Euthraulus) ortali* nov. sp. described at all stages. New features to distinguish the nymphs of the Mediterranean *Euthraulus* species are provided. One species of Palingeniidae has been found in the collections of Bet Gordon Museum in Deganya: *Palingenia orientalis* Chopra. The female of this species is described for the first time. *P. orientalis* disappeared from the investigated area in the early fifties.

Some geographical data are given on the distribution of the species inside and outside the investigated area, as well as some ecological observations. For instance, underwater emergence is reported for the first time in the genus *Afronurus*.

INTRODUCTION

The mayfly fauna of the Near East or Levant is still not well known. In a work devoted to the northern part of this area (mainly Turkey, Syria, Lebanon), KOCH (1988) lists the main important literature references available until now for this region.

Concerning Israel, the study and collecting of Ephemeroptera can be divided into three main periods.

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[1] Museum of Zoology, Palais de Rumine, P.O. Box 448, CH-1000 Lausanne 17, Switzerland.

The first one (1930-1960) is related to the work of Y. Palmoni from Bet Gordon Museum, who collected some mayflies, mainly in Lake Kinneret and Lower Jordan River area.

The second one (1967-1971) is the important contribution by SAMOCHA (1972), who dealt with a general survey of the Ephemeroptera of this country. With the help of this material, DEMOULIN (1973) published the first taxonomical work and described four new species of the family Heptageniidae.

The third one (1977-1990) is related to the work of the Inland-waters Ecological Service laboratory (IES) with the help of the River Surveillance System of the Nature Reserves Authority, Israel. During that time, more than 5'500 samplings have been made in more than 2'000 stations.

Recently, I had the opportunity to study the important collection of Dr. M. Samocha, deposited at Tel-Aviv University, as well as the huge collection of the Institute of Life Sciences in Jerusalem. The whole material was available through the courtesy of Dr. R. Ortal (Department of Zoology, The Hebrew University of Jerusalem and Nature Reserves Authority, Israel) who I sincerely thank for his cooperation. Moreover, I had the opportunity to travel twice to Israel in 1990 and 1991 and to collect material in the most important localities.

Almost twenty years after DEMOULIN (1973), I have to repeat the following foreword. Some localities where the material comes from, as well as some places where I had the opportunity to travel and collect material (mainly in the Golan Heights) are actually within the boundaries of Israel (cease-fire line of June 1967), but the property of such territories is always controversial.

This first contribution deals with the families Heptageniidae, Ephemerellidae, Leptophlebiidae and Palingeniidae. The remaining families will be published later by other specialists.

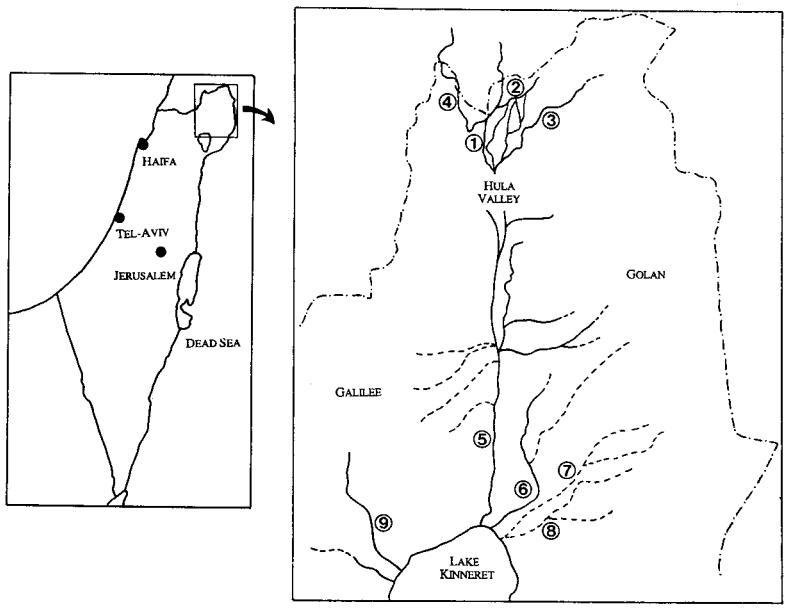
INVESTIGATED AREA

Nine among the eleven species belonging to the above mentioned families are only found in the North Eastern part of the country, i.e. mainly Hula Valley and Golan (map 1). This area is the only one to provide suitable habitats for the Heptageniidae, Ephemerellidae and most of the Leptophlebiidae. The fact that no representatives have been found in the streams and rivers of Lower and Upper Galilee (except two tributaries of Lake Kineeret, N. Amud and N. Zalmon), which offers also a good diversity of habitats, is probably due to the generally higher water temperatures of these streams (BROMLEY, 1988), as well as to human impacts on the environment (R. Ortal, comm. pers.). Other areas, such as Judea, Samaria, Negev and the coastal plain, do not possess cold permanent running waters, and so are only colonized by Caenidae and Baetidae species.

Concerning the two other taxa, the palingeniid species has been found in the Lower Jordan River (between Lake Kinneret and the Dead Sea), whereas one leptophlebiid species, belonging to the genus *Choroterpes* (subgenus *Euthraulus*) has been found only in some restricted places near the Dead Sea (N. Arugot, En Gedi).

HEPTAGENIIDAE

As already mentioned, this family has been worked by DEMOULIN (1973). Some complements are brought to the fore in this study. The Israeli fauna is peculiar in that it is composed of six genera, each comprising only a single species.



MAP 1.

Investigated area and detail of the North Eastern part with the main important watercourses. Dotted lines: temporary waters. 1: Nahal Senir (Hasbani River); 2: Nahal Dan, 3: Nahal Hermon (Banias); 4: Nahal Iyon (Ayoun River); 5: Upper Jordan River; 6: Nahal Meshushim; 7: Nahal Yadudiyya; 8: Nahal Daliyyot; 9: Nahal Amud.

KEY FOR THE IDENTIFICATION OF THE NYMPHS

This key is based on the one proposed by HEFTI & TOMKA (1989) for the European genera of Heptageniidae.

1 Nymph with two cerci, but no terminal filament ..... *Epeorus zaitzevi*
– Nymph with two cerci and one terminal filament 2

2 External borders of pronotum elongated caudally (fig. 5) ... *Ecdyonurus asiaeminoris*
– External broders of pronotum not elongated caudally 3

3 First gill lamellae expanded ventrally and bigger than the other ones .....
.....*Rhithrogena znojkoi*
– First gill lamellae not expanded ventrally and shorter than the other ones 4

4 Galea and lacinia with a row of setae on the ventral side (fig. 4); head trapezoid; VIIth pair of gills with a tuft of filaments (fig. 6) ..... *Heptagenia samochai*
– Galea and lacinia with scattered hairs on the ventral side (fig. 3); head rounded; VIIth pair of gills without a tuft of filaments (figs 8-9) 5

5 Anterior margin of labrum with a median notch (fig. 1); inner face of the femora with a distinct dark spot; VIIth gill broad and rounded (fig. 8) ..... *Afronurus kugleri*

– Anterior margin of labrum concave, without a median notch (fig. 2); inner face of femora with a transversal dark band; VIIth gill almost pointed (fig. 9) ..... *Electrogena galileae*

KEY FOR THE IDENTIFICATION OF THE IMAGOES

1 Upper face of femora with a distinct red to violet spot 2
– Upper face of femora without such spot (Caution! on lower face, a spot may be present!) 3

2 Tergites uniformly coloured; male and female genitalia as in fig. 11 and fig. 16 respectively ..... *Rhithrogena znojkoi*
– Tergites with posterior margin bordered with a darker narrow band (fig. 38); male genitalia as in fig. 10 ..... *Epeorus zaitzevi*

3 Transversal veins in the costal and subcostal fields broader than the others, tinted with violet (fig. 21) 4
– Transversal veins in the costal and subcostal fields normally build, brown or yellow, but never tinted in violet 5

4 Transversal veins in the costal field sinuous (fig. 21); male and female genitalia as in fig. 13 and fig. 18 ..... *Heptagenia samochai*
– Transversal veins in the costal field not sinuous; male and female genitalia as in fig. 12 and fig. 17 ..... *Ecdyonurus asiaeminoris*

5 Body colour reddish-brown; male and female genitalia as in fig. 15 and fig. 20 ..... *Electrogena galileae*
– Body colour light brown or even yellowish; male and female genitalia as in fig. 14 and fig. 19 ..... *Afronurus kugleri*

Epeorus zaitzevi Tshernova, 1981

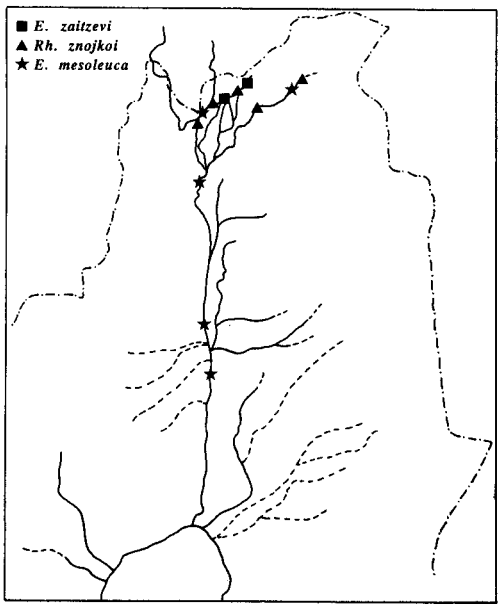
Epeorus sp. SAMOCHA, 1972
Epeorus sp. DEMOULIN, 1973
Epeorus znojkoi BRAASCH, 1978a nec TSHERNOVA, 1938
Epeorus zaitcevi KAZANCI & BRAASCH, 1988 (injust. emend.)
Epeorus zaicevi KOCH, 1988 (injust. emend.)

Material examined: 1♀ subimago, 16 N, more than 300 L from 122 samples in 7 localities along the Dan River.

For a description of the ♂, see TSHERNOVA (1981) and KAZANCI & BRAASCH (1988). For a description of the nymphs, see BRAASCH (1978a).

Despite the lack of ♂ imagoes, we agree with Braasch's opinion (in KOCH, 1988), that specimens illustrated by DEMOULIN (1973) belong to *E. zaitzevi*. The nymphs are similar to those described by BRAASCH (1978a) (sub. nom. *E. znojkoi*). Moreover, a peculiar feature of this species is the presence of a narrow dark band on the posterior margin of each abdominal tergite (see TSHERNOVA, 1981 fig. 3 p. 225, and also fig. 38). This character is visible both in nymphal and winged stages.

As for all known species of the genus *Epeorus* (DEGRANGE, 1960), the eggs of *E. zaitzevi* bear no peculiar exochorionic structures, nor polar cap (fig. 39). 2-3 micropyles visible in the equatorial area.



MAP 2.

Distribution of *E. zaitzevi*, *Rh. znojkoi* and *E. mesoleuca*. For explanations, see map 1.

Distribution: *E. zaitzevi* has been found only in the headwater of the Jordan (map 2) and seems to be exclusively restricted to the torrential part of the Dan River (see also POR *et al.*, 1986). In the visited localities, this species is rather common but is never abundant. So far known also from Caucasus (Armenia) (TSHERNOVA, 1981), Turkey (KAZANCI & BRAASCH, 1988) and from Syria (KOCH, 1988).

Rhithrogena znojkoi (Tshernova, 1938)

Ecdyonurus znojkoi TSHERNOVA, 1938
Rhithrogena sp. SAMOCHA, 1972
Epeiron znojkoi DEMOULIN, 1973
Rhithrogena sp. DEMOULIN, 1973
Epeorus znojkoi TSHERNOVA, 1981
Rhithrogena znojkoi THOMAS & DIA, 1982

Material examined: 1♂, 23 N, 77 L from 43 samples in 9 localities along the Banias, Dan and Hasbani Rivers.

The adults of *Rh. znojkoi* have been redescribed by THOMAS & DIA (1982), and the nymphs and eggs by SARTORI & SOWA (1992), where its affinities and proper status have been quoted. In the investigated area, *Rh. znojkoi* can be easily separated from all other species, both in adult and nymph stages. Differential diagnoses are available in SARTORI &

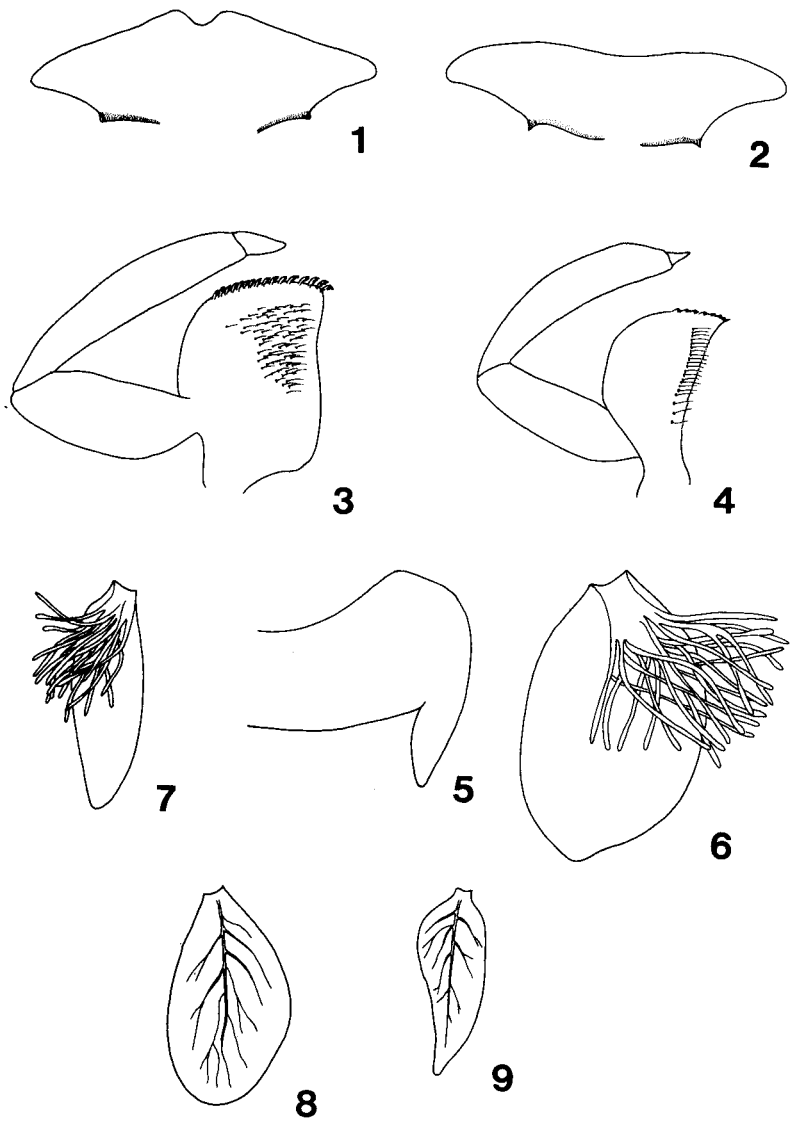
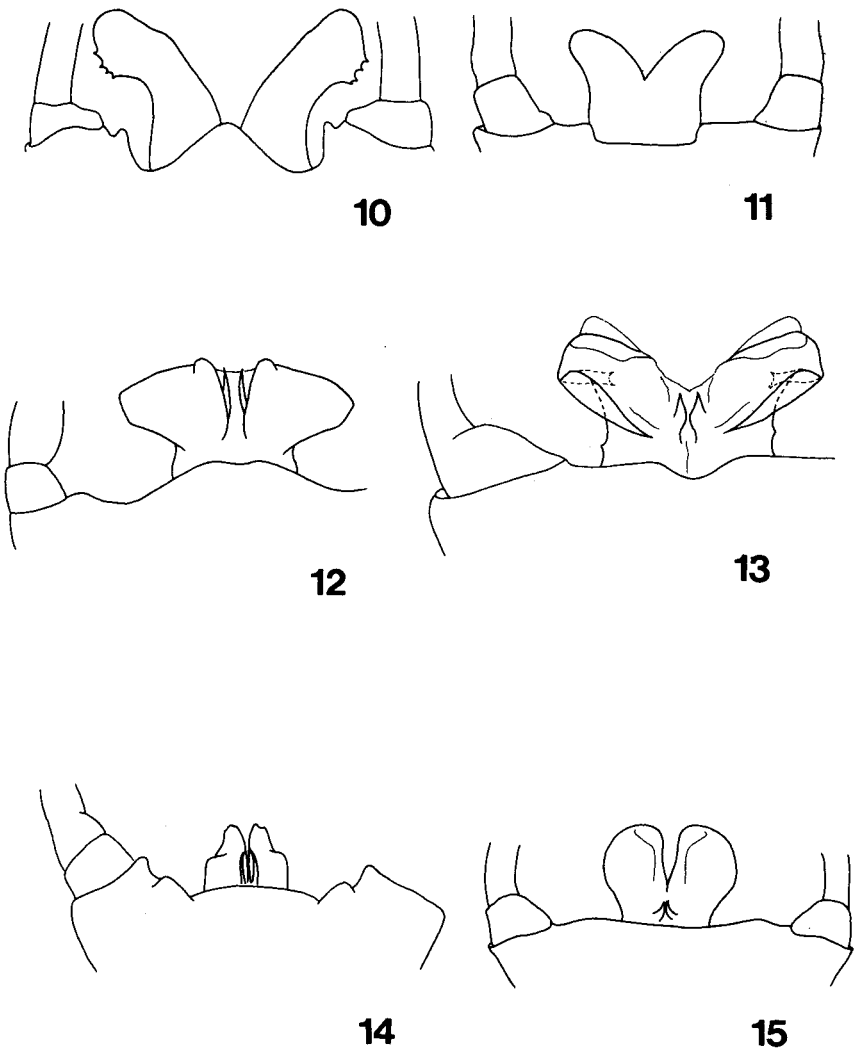


FIG. 1-9.

Heptageniidae nymphs. *A. kugleri* (1, 8), *E. galileae* (2, 3, 9), *H. samochai* (4, 6), *E. asiaeminoris* (5, 7). 1, 2: labrum; 3, 4: maxilla; 5: right half of the pronotum; 6-9: 7th gill.



FIGS 10-15.

Heptageniidae male genitalia in ventral view. 10: *E. zaitzevi*; 11: *Rh. znojkoi*; 12: *E. asiaeminoris*; 13: *H. samochai*; 14: *A. kugleri*; 15: *E. galileae*. Fig. 10 redrawn after KAZANCI & BRAASCH, 1988.

SOWA (op. cit.). The eggs of *Rh. znojkoi* are easily recognizable by the tooth-like shape of the exochorionic structures (fig. 40).

D i s t r i b u t i o n : *Rh. znojkoi* seems to be restricted to the Hula Valley, and particularly to the Dan and Hasbani Rivers, where this species is never abundant (map 2). Known also from Caucasus (Armenia) (TSHERNOVA, 1938), Lebanon (THOMAS & DIA, 1982; DIA, 1983; MOUBAYED, 1986), Turkey (KAZANCI & BRAASCH, 1988; KOCH, 1988) and Syria (KOCH, 1988).

Ecdyonurus asiaeminoris Demoulin, 1973

Ecdyonurus galileae SAMOCHA, 1972 nec DEMOULIN, 1973!

M a t e r i a l e x a m i n e d : 2♂, 6♀, 79 N, more than 260 L from 75 samples in 10 localities along the Dan, Hasbani and Banias Rivers.

This species belongs to the so-called "*venosus* group", and is really easy to recognize, especially in larval stages. The seventh pair of gills bears also a tuft of tracheous filaments, as the six previous ones (fig. 7). Only one species shares the same feature: *E. insignis* Eaton, an inhabitant of European rivers. The transversal veins tinted with violet in the fields C and Sc of the forewings also allow separation of the winged stages. *E. asiaeminoris* presents no clear affinities with other members of the genus *Ecdyonurus* known to occur in Near- and Middle East, although some similar characters with *E. ornatipennis* Tshernova could be found (TSHERNOVA, 1938; BRAASCH, 1980a). The eggs of *E. asiaeminoris* are characterized by medium size KCTs, regularly arranged on the chorionic surface, except on one pole where they are bigger and all closer (fig. 41). Small rounded tubercles are also found on the surface. 7-8 micropyles present in the subequatorial area.

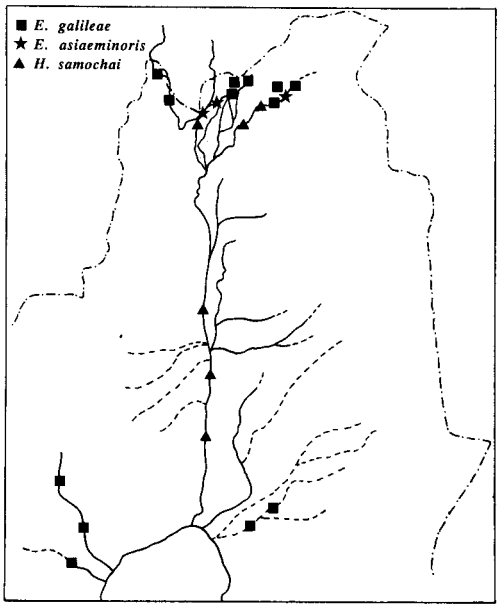
D i s t r i b u t i o n : this species seems to be restricted to the Hula Valley, and especially Hasbani River after the confluence with the Dan River (map 3). The species occurs really scarcely in Banias and Tel Dan for instance, but is abundant in Dan river from Dan 5 locality (see POR *et al.*, 1986; ALLAN *et al.*, 1988 for localisation of the sites). *E. asiaeminoris* has never been quoted outside this area, and is unknown from Turkey, Lebanon or Syria for instance.

Afronurus kugleri Demoulin, 1973

Afronurus kugleri SAMOCHA, 1972
Afronurus kugleri DIA, 1983
Afronurus kugleri MOUBAYED, 1986
Afronurus kugleri KOCH, 1988

M a t e r i a l e x a m i n e d : 27♂, 22♀, 91 N, more than 450 L from 119 samples in 43 localities along 17 watercourses.

A. kugleri is the second species of this genus known from the Mediterranean area. It shares some common features with its closest relative *A. zebratus* (Hagen) known exclusively from Corsica and Sardinia. The main differences between these two species concern the galea-lacinia of the nymphs. In *A. kugleri*, the distal part of the galea-lacinia bears 13-15 combs, the median ones with 9-10 teeth (fig. 22), whereas in *A. zebratus*, 19-21 combs can be found, the median ones with 15-18 teeth (fig. 23). The peculiarities of egg exochorionic structures of *A. zebratus* (GAINO & MAZZINI, 1987; GAINO *et al.*, 1987) can also been observed in *A. kugleri*. The whole surface of the chorion is covered with KCTs (fig. 42), and resembles what is found in *A. zebratus*.



MAP 3.

Distribution of *E. galileae*, *E. asiaeminoris* and *H. samochai*. For explanations, see map 1.

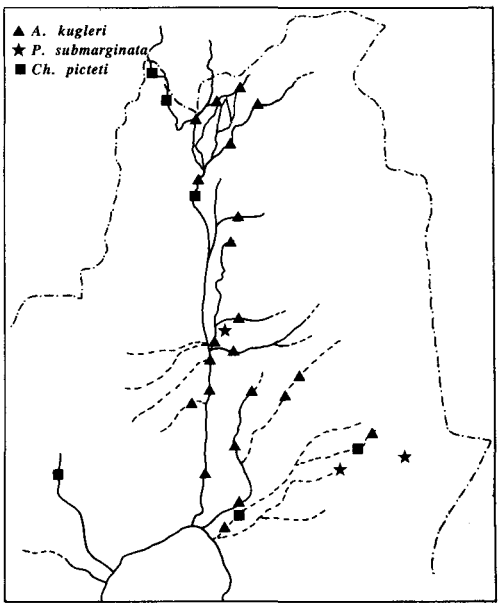
Distribution: *A. kugleri* is the most widespread Heptageniidae in Israel. It occurs in the Hula valley, the Golan Heights as well as in the Upper Jordan River (map 4). Known also from Lebanon (DIA, 1983; MOUBAYED, 1986) and from Turkey and Syria (KOCH, 1988).

A. kugleri seems to be more tolerant than other Heptageniidae, especially with regards to the temperature, i.e. this species can colonize other streams and rivers where the other ones are missing for (N. Meshushim, N. Samakh, N. Yahudiyya, N. Zavitan for instance).

During our researches in the field, as well as during the rearings, we had the opportunity to observe the subimaginal emergence of *A. kugleri*. It was surprising to find this species has an underwater emergence. The nymphs begin to molt a few centimeters below the water level (under artificial conditions), the subimagoes then "swim" rapidly towards the surface for emergence. Until now, underwater emergence was known to occur only in the genus *Electrogena* (KIMMINS, 1941 and pers. obs.). The fact that *A. kugleri* (and probably also *A. zebratus*) exhibits the same behaviour also confirms the strong morphological and biochemical relationships between these two genera (HEFTI & TOMKA, 1989).

Electrogena galileae (Demoulin, 1973) **comb. nov.**

Ecdyonurus golanicus SAMOCHA, 1972 nomen nudum
Ecdyonurus galileae DEMOULIN, 1973
Ecdyonurus galileae DIA, 1983
Ecdyonurus galileae MOUBAYED, 1986
Ecdyonurus galileae KOCH, 1988



MAP 4.

Distribution of *A. kugleri*, *P. submarginata* and *Ch. picteti*. For explanations, see map 1.

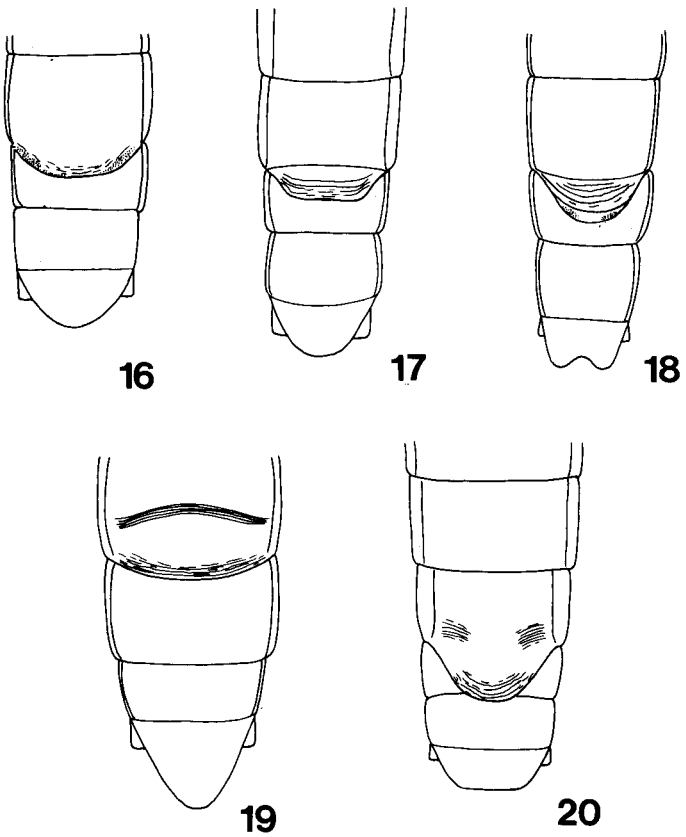
Material examined: 56♂, 14♀, 162 N, more than 270 L from 96 samples in 28 localities along 14 watercourses.

By its distinctive features both in nymphal and adult stages, *E. galileae* clearly belongs to the genus *Electrogena* Zurwerra & Tomka, 1985. But a comparative study of *E. galileae* with its close relatives is still not possible at the moment. This is mainly due to the great number of species only partly described during the last decade from nearby areas, mainly Caucasus and Transcaucasus (BRAASCH, 1978b, 1980a, 1980b, 1983). Nevertheless, the status of *E. galileae* as *species propria* is certainly good for it can be distinguished from all other species described before 1973. The eggs of this species are typical for the genus and resemble those of *E. grandiae* for instance (GAINO *et al.*, 1987). They are characterized by medium size KCTs and rounded tubercles covered by granular ground matrix. 4-5 micropyles are found in the equatorial area (fig. 43).

Distribution: In Israel, *E. galileae* occurs mainly in the Hula valley, where it is particulary abundant in the sources regions, such as Tel Dan springs, Banias (map 3). Also reported from Lebanon (DIA, 1983; MOUBAYED, 1986) and Syria (KOCH, 1988). But I am not sure the citations outside Israel are correct. The examination of undetermined material from Lebanon (A. Dia & A.G.B. Thomas leg.) indicates that there are at least two species belonging to the genus *Electrogena* in this country, neither of them related to *E. galileae*.

Heptagenia samochai (Demoulin, 1973) **comb. nov.**

Sigmoneuria samochai SAMOCHA, 1972
Sigmoneuria samochai DEMOULIN, 1973
Heptagenia lutea KLUGE, 1987 **(syn. nov.)**



FIGS 16-20.

Heptageniidae female genitalia in ventral view. 16: *Rh. znoijki*; 17. *E. asiaeminoris*; 18. *H. samochai*; 19: *A. kugleri*; 20: *E. galileae*.

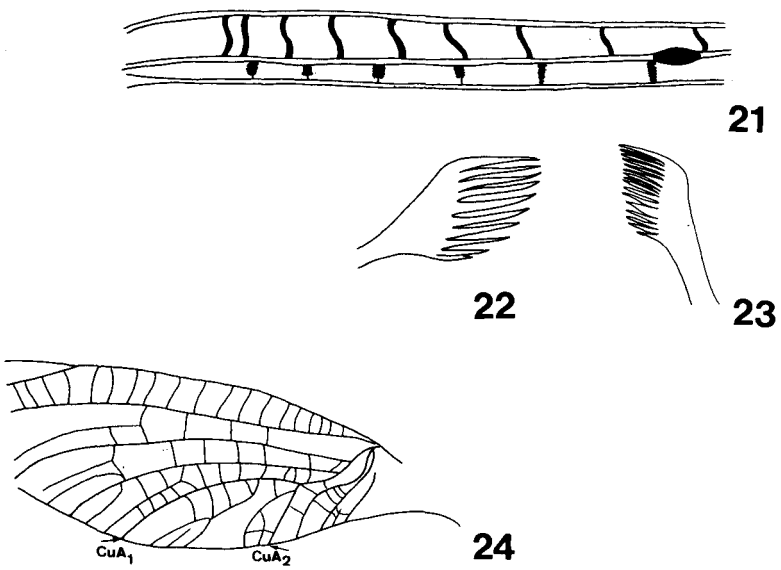
Material examined: 37♂, 37♀, 19 N, 94 L from 31 samples in 17 localities along the Dan, Hasbani, Banias and Upper Jordan Rivers.

The ♂ imago of this species was not known from DEMOULIN (1973). We give here below its first description.

Size: body length: 11.9 - 14.5 mm; forewing: 11.3 - 12.0 mm; cerci: 22.0 - 25.0 mm.

Eyes uniformly greyish. Antennae with yellowish-brown pedicel and whitish funicule.

Thorax more or less uniformly yellowish-brown. A small, dark elongated spot on the metapleurites. Forelegs light brown, with blackish junction between tarsi and tibiae. Middle and hindlegs yellowish. Wings translucent. Longitudinal veins brown. Transversal veins of the costal and subcostal fields tinted with violet or black. In the proximal part of the forewing, transversal veins of the costal field slightly sinuous, those of the subcostal field tinted in violet and more or less quadratic (fig. 21).



FIGS 21-24.

21. Proximal part of the costal and subcostal fields of the forewing in *H. samochai*; 22: comb of the galea-lacinia in *A. kugleri*; 23: comb of the galea-lacinia in *A. zebratus*; 24: cubito-anal field of the forewing in *P. orientalis*.

Abdomen colourless, except tergites I-III whitish and segments VIII-X whitish-brown. Cerci whitish, every other junction strongly coloured in violet.

Genitalia (fig. 13): general colour whitish. Styliger plate with a median smooth concave incision. On each penis lobe, ventral tooth long and regularly curved. Titillators short, pointed and straight.

The eggs of *H. samochai* are similar to those found in other species, such as *H. sulphurea* (Müller) or *H. coerulans* (Rostock) for instance (DEGRANGE, 1960). They are characterized by medium size KCTs, bigger on the polar cap, and a great number of micropyles (8-12) in the equatorial area (fig. 44).

As already mentioned by BRODSKY (1980) and by KLUGE (1989b) the genus *Sigmoneuria* has no phylogenetic existence, and therefore has to be regarded as a junior synonym of *Heptagenia*. *H. samochai* is a very distinct species, both in imaginal and larval stages, and presents no clear affinities with species such as *H. coerulans* or *H. longicauda* (Stephens). By the shape of the cross veins in the C and Sc fields, *H. samochai* resembles *H. perflava* Brodsky, 1930 but can be separated on the shape of the penis lobes and titillators. Another related species is *H. lutea* Kluge, described from Caucasus, Armenia, Azerbajidzan, Georgia and Iran (KLUGE, 1987). I had the opportunity to compare *H. samochai* with specimens coming from Elbourz mountains in Iran (near Bujnurd, coll. F. Schmid). These specimens completely fit the description given by KLUGE (op. cit.), and therefore can be regarded as *H. lutea*. The only differences found between *H. samochai* and *H. lutea* are the shape of the cross veins in the subcostal field, triangular in *H. lutea*, whereas quadratic in *H. samochai* as well as

the margin of the styliger plate, smoother in *H. lutea* than in *H. samochai*. We could compare only the male imagoes but strong affinities are also visible in the nymphal stage, especially in the labrum and gill shape (see figs. 42-45 & 50 in KLUGE, 1987). Moreover, it is also Kluge's opinion (in litt.) that *H. lutea* has to be regarded as a junior synonym of *H. samochai*.

D i s t r i b u t i o n : *H. samochai* is mainly restricted to the Hula valley and the Upper Jordan River (map 3). Outside Israel, *H. samochai* is also found in Georgia, Armenia, Kimea and Elbourz montains (KLUGE, 1987, 1989a).

EPHEMERELLIDAE

This family is represented in the investigated area by a single species.

Ephemerella mesoleuca (Brauer, 1857)

Ephemerella maculocaudata IKONOMOV, 1961b
Ephemerella sp. n. SAMOCHA, 1972
Ephemerella mesoleuca KOCH, 1988

M a t e r i a l : 6♀, 9 N, 23 L from 14 samples in 6 localities along the Hasbani, Banias and Upper Jordan Rivers.

The specimens from Israel perfectly fit the diagnosis of *E. maculocaudata* Ikonomov, 1961 given by SOLDAN (1982) on the basis of material collected in Bulgaria. But recently, STUDEMANN & TOMKA (1989) have proposed the synonymy between these two species. Although some variations such as the size and position of the transversal dark band on the cerci can be noticed between populations (see also ALBA-TERCEDOR, 1991) they have to be regarded as belonging to the same species *E. mesoleuca* (D. Studemann, comm. pers.)

D i s t r i b u t i o n : *E. mesoleuca* has been found mainly in the Upper Jordan River (map 2). It is also known from Banias and Hasbani Rivers where Samocha collected it, but this species has not been found again in these localities since 1971, where it has probably disappeared from.

Found also by KOCH (1988) in Syria (Orontes) but evidence of its distribution in other Levantine countries, mainly Lebanon and Turkey, is not yet established.

LEPTOPHLEBIIDAE

In his work, SAMOCHA (1972) reported three leptophlebiid species from Israel, none of them specifically identified, and belonging to the genera *Paraleptophlebia* and *Choroterpes* (subgenera *Choroterpes* and *Euthraulus*). In the examined material, only these three taxa have been found, each of them represented by a single species.

Paraleptophlebia submarginata (Stephens, 1835)

Paraleptophlebia sp. SAMOCHA, 1972

M a t e r i a l e x a m i n e d : 1♂, 4 L from only 4 samples in 4 small watercourses (En Abu Fakusa, En Jalabina, En Qusbyie, Nahal Gamla).

The Israeli specimens completely fit the diagnosis for this species, and therefore present no differences with European populations. Both nymphs and imagoes are easy to recognize.

Distribution: probably one of the less abundant species in Israel. *P. submarginata* seems to be restricted to the Golan Heights (map 4), and has not been found in other places, especially in the Hula valley. Outside the country, the species is known from Iran (BRAASCH, 1981) and Turkey (KAZANCI, 1986). This species is widespread in Europe (PUTHZ, 1978).

Choroterpes (Choroterpes) picteti Eaton, 1871

Choroterpes (s.s.) sp. n. SAMOCHA, 1972

Material examined: 5♂, 5♀, 20 N, 35 L from 12 samples in 8 localities along 8 watercourses.

This species, thought to be new by SAMOCHA (1972), is in fact the same species which occurs in Europe. Its distinctive features from other new species described recently from the Mediterranean area, such as *Ch. volubilis* Thomas & Vitte, 1988 (Morocco) or *Ch. borbonica* Belfiore, 1988 (southern Italy) are well marked, especially the shape of the penis lobes and the colouration of the forewings.

Distribution: *Ch. picteti* has been found in the Golan Heights and also in the Hula valley (map 4). Known also from Lebanon (DIA, 1983) and Turkey (KAZANCI, 1984).

Choroterpes (Euthraulus) ortali nov. sp.

Choroterpes (Euthraulus) sp. SAMOCHA, 1972

Material examined: 1♂ imago holotype (with its nymphal exuviae); 2♂♂ imagoes, 1♂ subimago, 3♀♀ imagoes, 2♀♀ subimagoes, 15 nymphs paratypes: Israel, Dead Sea Area, Nahal Arugot (En Gedi), -300 m below sea level, 12.V.1991 (coll. M. Sartori). Other paratypes: 1♂ imago, 1♂ subimago, 2 nymphs, same locality, 15.V.1990 (coll. R. Ortal & M. Sartori); 3 nymphs, same locality, 6.XII.1990 (coll. R. Ortal). Other material (not type specimens): more than 500 larvae and nymphs from the same wadi (coll. Nahal Arugot project); 1 larva, Ein Doyuq, 8.III.1970 (coll. Avrahami) and 1 larva, En Mishmar, 25.II.1970 (coll. Gasith). All specimens preserved in alcohol except one ♂ paratype partly in microscopic preparation (wings, genitalia). Holotype and most of the paratypes housed in the Musée de Zoologie, Lausanne. 1♂ imago, 1♂ subimago, 1♀ imago, 1♀ subimago and 4 nymphs paratypes are deposited in the Museum of Zoology of the Tel-Aviv University.

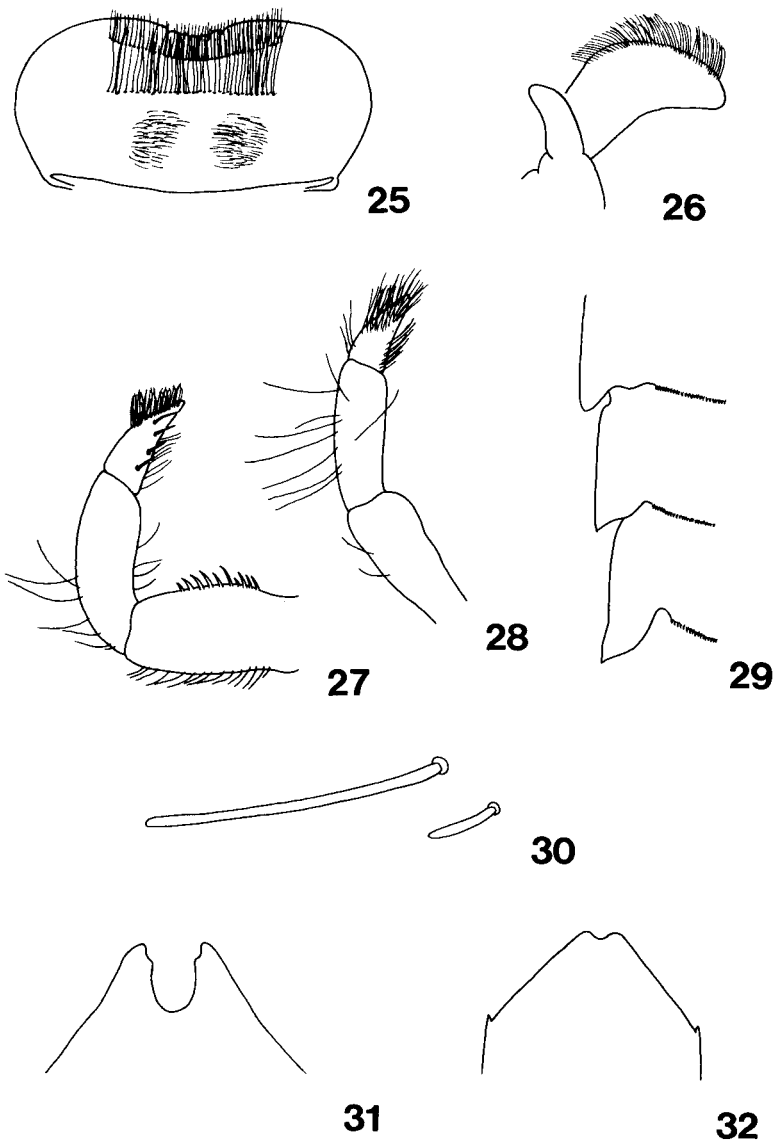
Description

Nymph

Sizes (without cerci): ♂ nymphs up to 6.3 mm; ♀ nymphs up to 7.5 mm.

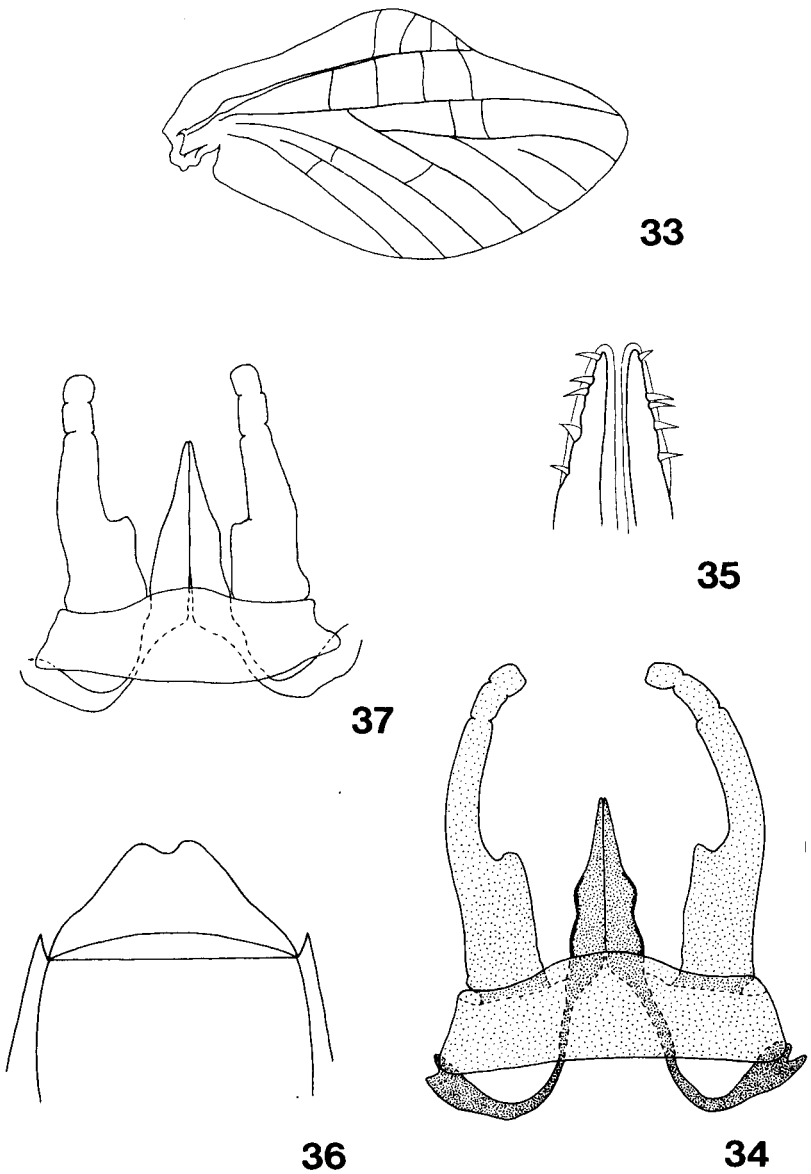
Head medium brown; thoracic sclerites dark brown. Legs yellowish-brown. Upper face of femora with an elongated dark spot in the distal part. Abdominal tergites greyish-brown, sternites yellowish-brown. Cerci light brown, proximal part darker.

Anterior margin of the labrum with a very smooth emargination, and with two rows of fine setae (fig. 25). Antero-lateral projection of the lacinia with a small projection. 2nd/3rd segments of the maxillary and labial palps ratio about 1.7 (figs 27-28). Hypopharynx as in fig. 26. Legs with the same kind of ornamentation as in *Ch. (Eu). arabica* (SARTORI & GILLIES, 1990). Hind tibiae with a row of 24-27 external bristles (fig. 30). Tarsal claws moderately hooked, with 13-14 teeth. Gills typical of the subgenus *Euthraulus*, with gill I lanceolate, and gills II-VII with two lamellae plate-like and terminated in three slender, subequal processes. Lateral margin of terga VII-IX as in fig. 29. IXth sternite of male and female nymphs as in fig. 31 and fig. 32 respectively.



FIGS 25-32.

Ch. (Eu.) ortali nov. sp. Nymph. 25: labrum; 26: left half of the hypopharynx; 27: labial palp; 28: maxillary palp; 29: lateral margin of abdominal tergites VII-IX; 30: bristles on the outer margin of hind tibiae; 31: sternite X in male nymph; 32: sternite X in female nymph.



Figs 33-37.

Ch. (Eu.) ortali nov. sp. Male imago (33-35), female imago (36), male subimago (37). 33: hind wing; 34: genitalia in ventral view; 35: detail of the penis lobes in ventral view; 36: subanal plate; 37: genitalia in ventral view.

Male imago

Size: body length: 7.8 - 8.2 mm; forewing: 6.4 - 6.6 mm; cerci: 8.8 - 9.4 mm.

Upper part of the eyes brownish-red. Thoracic sclerites dark brown. Femora of all legs greyish-brown with an elongated spot in the distal part of the upper face, as in the nymphs. Femoro-tibial joints medium brown. Tibia and tarsi yellowish-brown. Abdominal terga greyish-brown, sterna lighter except the IXth medium brown.

Forewings translucent, except basis of C, Sc and R veins medium brown, and pterostigmatic area milky. Pterostigma with 9-12 simple transversal veins. Rs vein forked a little bit nearer to base of wing than attachment of vein MP_2 to MP_1. MA forked over half of distance from base to margin. MP vein asymmetrical. 4 longitudinal veins in the cubital area. Hindwings with a rounded and symmetrical process; subcostal vein reaching the costa immediately behind the process (fig. 33).

Genitalia

Subgenital plate medium brown; forceps yellowish-brown. Hind margin of the subgenital plate regularly convex, without incision. First segment of the forceps very broad in the proximal half, suddently reduced in the apical half, forming a small rounded inner process (fig. 34). Penis lobes well developed, scissor-like, pointed at their apex which bears about 5 small spines (fig. 35).

Female imago

Size: body length: 5.8 - 6.2 mm; forewing: 6.5 - 6.8 mm; cerci: 6.0 - 7.5 mm.

Thorax dark brown, wings entirely translucent. Abdominal tergites medium brown, sternites greyish-brown. Subanal plate elongated with a median incision (fig. 36).

Male subimago

General colour as for the ♂ imago, but more contrasted.

Wings entirely greyish, except the proximal part of the forewings greyish-brown. Genitalia as in fig. 37.

Female subimago

General colour of the abdomen reddish brown. Wings greyish.

Eggs

General shape ovoid. Length: 170-180 µm, width: 95-105 µm. Exochorionic structures with cross and asteroid costae (fig. 45). In the middle of them, a small adhesive element is present which is bigger on one pole.

Affinities

In nymphal stage, *Ch. (Eu.) ortali* shares some common features with other representatives of the Mediterranean area. It can be separated from *Ch. (Eu.) lindrothi* (Peters, 1980), Ch. *(Eu.) balcanica* (Ikonomov, 1961) and *Ch. (Eu.) assimilis* Gaino & Sowa, 1985 by the shape of the labrum, especially the less marked median emargination. Other mouth parts rather similar, as well as gills. Legs ornamentation can also provide good features to separate these four species, especially on the hind legs. The shape and number of the bristles on the outer margin of the hind tibiae are rather constant in each species. In *Ch. ortali*, there are 24-27 long, subparallel bristles, rounded at the apex, whereas they are shorter, less numerous and enlarged at the apex in *Ch. assimilis*, and much longer, less numerous, and pointed at the apex in *Ch. lindrothi*. In *Ch. balcanica*, they seem to be shorter and less numerous (see IKONOMOV, 1961a, fig. 9, p. 6).

In winged stages, *Ch. ortali* can be compared with certainty only to *Ch. lindrothi* and *Ch. arabica*, for male imagoes of *Ch. balcanica* and *Ch. assimilis* are still unknown. Genitalia of *Ch. ortali* are quite different from those of *Ch. lindrothi*, especially in the shape of the penis. It presents some affinities with *Ch. arabica*, but can be separated by the shape of the first segment of the forceps, as well as by the outer margin of penis lobes. ♂ subimago of *Ch. ortali* can be distinguished from the one of *Ch. assimilis* by the shape of the penis lobes. On the basis of wing venation, distinctive features are hard to find between *Ch. ortali* and *Ch. balcanica*, although the subcostal vein of the hind wing seems longer in *Ch. balcanica* than in *Ch. ortali*.

Finally, the eggs of *Ch. ortali* are easily distinguishable from those of *Ch. assimilis* (no exochorionic structures), *Ch. lindrothi* and *Ch. arabica* (polar cap, size and shape of the costae).

Distribution: *Ch. ortali* has been found to occur widely in one tributary of the Dead Sea, Nahal Arugot, where this species is rather common. Prospections in the nearby wadi Nahal David where surprisingly fruitless. Information on the type locality is available in FURTH (1983). Known so far only from that area.

Derivatio nominis: this species is named after Dr. Reuven Ortal (Jerusalem) for his tremendous help during the whole study.

PALINGENIIDAE

The occurence of a Palingeniidae species in the Jordan River has been known since the mid-thirties (BODENHEIMER, 1935). But the specific identification of the population living in this watercourse was still enigmatic. BODENHEIMER (1935) reported the mass-flight of the gigantic species *Palingenia jordanica*, but unfortunately gave no description of this mayfly. In 1937, the same author proposed the synonymy of *P. jordanica* with *P. orientalis* Chopra. This synonymy has been done in fact by Y. Palmoni (1897-1971), who was the founder and director of "Bet Gordon", the A.D. Gordon Agriculture and Nature Study Institute at kibbuz Deganya (LULAV, 1972). In 1939 specimens were sent to Dr. G. Ulmer for examination, and returned identified as *P. longicauda* (Olivier). Later on, other material was sent to Prof. V. Landa who determined them as *P. sublongicauda* Tshernova. This specific name has been used by SAMOCHA (1972) and remained until now. Thanks to the courtesy of S. Lulav, the actual director of Bet Gordon, we had the opportunity to study the collections of this institution. Among them, 19 Palingeniidae specimens are still available. They are all ♀♀. No nymphs nor ♂♂ are preserved. However, these specimens could be related to Chopra's species, especially on the basis of their peculiar forewing venation.

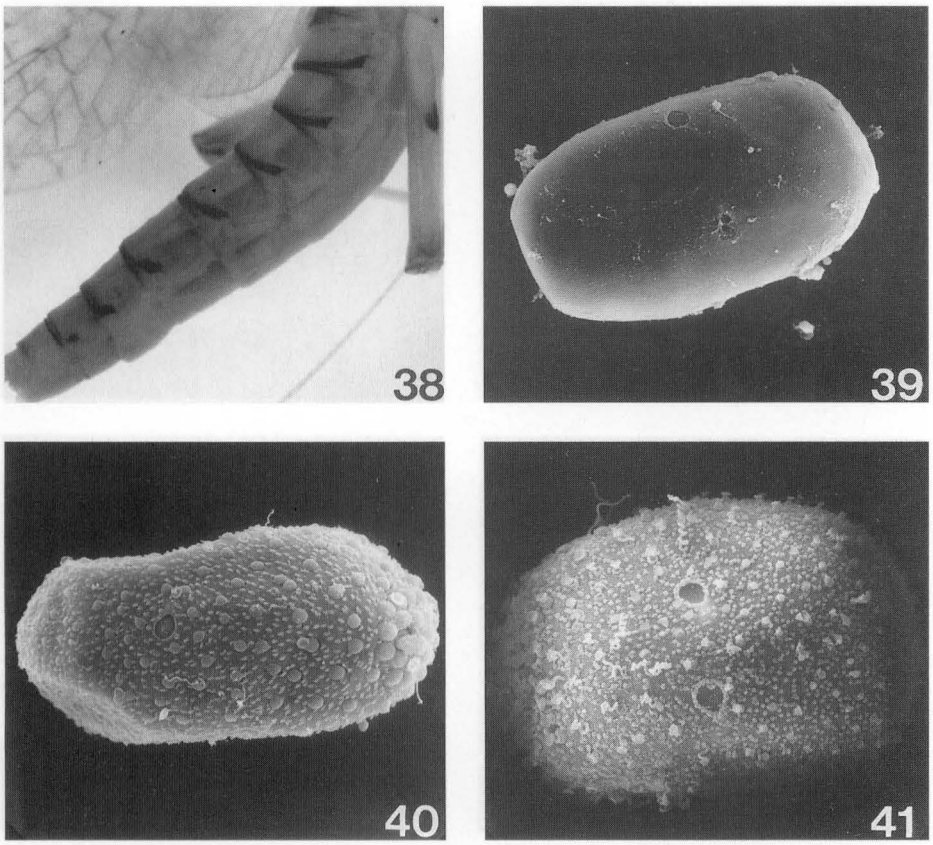
Palingenia orientalis Chopra, 1928

Palingenia jordanica BODENHEIMER, 1935 nomen nudum!
Palingenia orientalis BODENHEIMER, 1937
Palingenia sublongicauda SAMOCHA, 1972 nec Tshernova, 1949

Material examined: 10 ♀♀: Israel, Lower Jordan River, Deganya (outlet of Lake Kinneret), -210 m below sea level, 7.IV.1944. Other specimens, all from the same place: 1 ♀ 29.III.1935, 7 ♀♀ 27.III.1944, 1 ♀ 29.III.1947 (coll. Y. Palmoni).

Description (dried specimens)

Size: body length (without cerci): 22-31 mm; forewing: 24-29 mm; cerci broken.



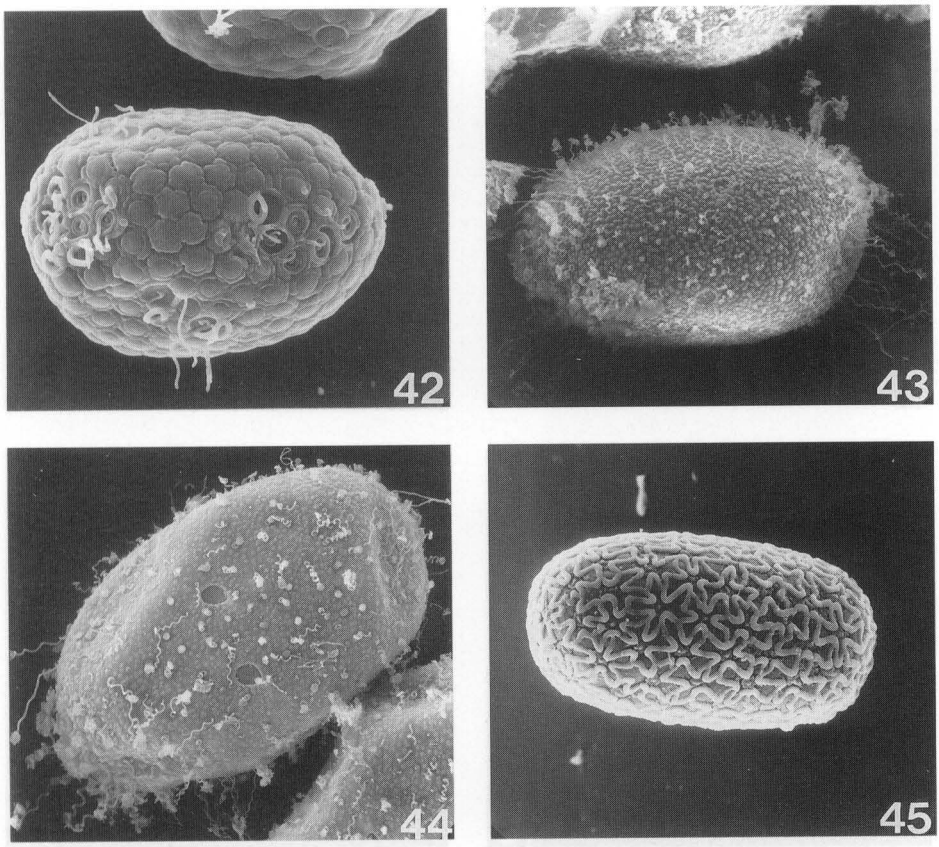
FIGS 38-41.

Female subimago (37) and eggs (38-41). 38-39: *E. zaitzevi*; 40: *Rh. znojkoi*; 41: *E. asiaeminoris*.

General coloration yellowish brown. Head yellowish; eyes black, as well as intraocellar area. Thorax medium brown, legs yellowish. Wings uniformly milky, longitudinal veins (especially C, Sc, R and MA) tinted in yellow. Abdominal tergites I-VI yellowish brown, VII-X light brown, without specific patterns; sternites uniformly light yellow. Cerci light brown.

Forelegs short, twisted but not really atrophied. Middle and hindlegs normally built, the hind ones longer. On all tarsi, double claws, one hooked, the other obtuse. Inner border of the forewings regularly curved, without any winding. Vein MA forked over half of the distance from base to margin. 2 ICuA present. Vein CuA clearly bifid, CuA_1 long and regularly curved whereas CuA_2 short and reaching the border almost in a straight line (fig. 24).

In Palingeniidae, wing venation, especially in the forewing, gives good criteria even to distinguish the taxa at the specific level (DEMOULIN, 1965; Soldán, comm. pers.). The examined specimens present the same peculiar cubito-anal venation as mentioned by GRAVELY (1920) and CHOPRA (1928). Moreover, they belong without any doubt to the genus *Palingenia*: regularly curved forewing, head without cephalic processes, vein MA



FIGS 42-45.

Eggs. 42: *A. kugleri*; 43: *E. galileae*; 44: *H. samochai*; 45: *Ch. (Eu.) ortali*.

forked over half the distance from base to margin. Among the species belonging to that genus, *P. orientalis* can be easily separated from *P. longicauda* (Olivier), *P. fuliginosa* (Georgi), *P. sublongicauda* Tshernova and *P. apatris* Demoulin, in which vein CuA_2 is always much longer and not attached to CuA_1 as in *P. orientalis*. This peculiar branching of CuA is found for instance in most of *Anagenesia* species (DEMOULIN, 1965). But in this genus, MA vein is always forked nearer the base than margin.

B i o n o m y . – The following information is based on the unpublished notes of Y. Palmoni. In Israel, *P. orientalis* was located in the Lower Jordan river, i.e. downstream to Lake Kinneret. One peculiarity of *P. orientalis* was to emerge and fly in the early morning (between 5 and 8 a.m.). In comparison, SOLDAN (1978) reports for *P. sublongicauda* early morning or evening emergences, whereas for *P. longicauda* and *P. fuliginosa*, only evening emergences have been reported (RUSSEV, 1987; SOLDAN & LANDA, 1986; pers. obs.). Most of the occurences reported here come from the Jordan River near Deganya (outlet of Lake Kinneret). *P. orientalis* has been observed from 1935 to 1950. Emergence

and flight took place from end of March (earliest date: 27.III.1944) until the beginning of May (latest date: 5.V.1939). Specimens began to fly before 6 a.m. until 7.30 or 8 a.m. On the 27th of March 1944, Palmoni noted that at 9 a.m., about 10% were still alive. Since 1950 (4.V.1950), no more specimens have been collected, nor observed, in spite of a survey in the area for several years. According to ORTAL & POR (1978), as well as information communicated by R. Ortal (Jerusalem) the disappearance of *P. orientalis* is related to human impact along the Jordan watercourse, where the suitable habitats for the larvae have been destroyed by new buildings for irrigation or electric power stations.

P. orientalis was described from populations in Seistan (eastern Iran) and was never quoted since that time. The Jordan River population extends far to the west of the original distribution area of this species. No *Palingenia* species have been reported inbetween. The only Palingeniidae known from Middle East is *Mortogenesia mesopotamica* (Morton) from Iraq, but this species has few morphological affinities with representatives of the genus *Palingenia* (DEMOULIN, 1965).

P. orientalis has to be considered as having disappeared from Israel as well as Jordan. Evidence of remaining populations in the area or even elsewhere is not known.

BIOGEOGRAPHY OF THE STUDIED ELEMENTS

Although Israel belongs to the Palaearctic region, it is situated near the border of the Afrotropical region to which it is connected through the Rift Valley (see POR, 1975; TCHERNOV, 1988).

One species probably originated from Afrotropical region, the leptophlebiid *Ch. (Eu.) ortali*, found in the Dead Sea area. The subgenus *Euthraulus* is well represented by several species in Africa, as well as in the Oriental region (PETERS & EDMUNDS, 1970). This species is also the only one of the studied families to be present outside the northern part of the country.

The genus *Palingenia*, represented here by the species *P. orientalis*, is a west Palaearctic element.

All the other species are more or less restricted to the headwaters of the Jordan, the Hula Valley, and some streams in the Golan Heights, as for Israeli stoneflies species (BROMLEY, 1988). They are all Palaearctic elements although their origin is probably different. The two leptophlebiid species *Ch. (Ch.) picteti*, *P. submarginata* as well as the ephemerellid *E. mesoleuca* probably have an European origin, and they reach their most south-eastern boundaries in the Levant. In contrast, none of the heptageniid species are known from Europe. They can be divided in two main categories. First, species endemic to the Levant, such as *E. galileae*, *E. asiaeminoris* and *A. kugleri*. If *E. asiaeminoris* probably has a west Asiatic origin, *E. galileae* could be a Pontic element, whereas an African origin for *A. kugleri* is probable. Secondly, Caucaso-Levantine species such as *E. zaitzevi*, *Rh. znojkoi* and *H. samochai*. These species are distributed from the foothills of the Caucasus, through Turkey, Syria, Lebanon and they reach their southern boundary in the headwaters of the Jordan.

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also to Prof. G. Lampel (Fribourg) for his russian translation of Kluge's description of *H. lutea*, and to Denise Studemann and Dr. Peter Landolt (Fribourg) for helpful discussion on the *Ephemerella* species. My gratitude to Dr. Tomas Soldán (Ceske Budejovice) for helpful advices, for allowing me comparison with other *Palingenia* species, and for his hospitality during my short visit in his laboratory. I am indebted to Dr. Heather J. Bromley (Jerusalem) for improving the English. The SEM photographs have been realized at the Electronic Microscopy Center of the Lausanne University.

My stays in Israel in May 1990 and 1991 were made possible through a grant of the Swiss Academy of Sciences (travel funds), as well as financial support by the Museum of Zoology in Lausanne. The stay and travelling in Israel were arranged by the Nature Reserves Authority wardens, especially by Dror Pevzner and Hillel Glassmann during my stay in the kibbouz Ortal (Golan), and by Gershon Goldstein and Avi Reuven during my stay in Tel Dan. Special thanks also to all the staff of the En Gedi Nature Reserve, especially to Ya'al Dolev for accomodation. I am also grateful to Avi Reuven (She'ar Yashuv) and Glassmann's family (Harashim) for their friendly hospitality. Last but not least, nothing could have been realized without help and licence for collecting material in the Reserves provided by Reuven Ortal (Jerusalem), as well as for all accomodation and help during my field trips in Israel.

RÉSUMÉ

Cet article constitute la première partie d'un travail consacré à l'étude des Ephéméroptères d'Israël. Onze espèces sont citées. La famille la plus diversifiée est celle des Heptageniidae avec six genres renfermant chacun une seule espèce: *Rhithrogena znojkoi* (Tshernova), *Epeorus zaitzevi* Tshernova, *Ecdyonurus asiaeminoris* Demoulin, *Electrogena galileae* (Demoulin) (comb. nov.), *Afronurus kugleri* Demoulin et *Heptagenia samochai* (Demoulin) (comb. nov.). *E. zaitzevi* est nouveau pour la faune d'Israël. Le mâle de *H. samochai* est décrit pour la première fois, et la synonymie avec *H. lutea* Kluge (syn. nov.) est proposée. Les œufs des six espèces sont décrits et illustrés. Des clés de détermination pour les mâles et les larves sont inclues. Les Ephemerellidae sont représentés par une seule espèce, *Ephemerella mesoleuca* (Brauer). Les espèces de Leptophlebiidae sont: *Paraleptophlebia submarginata* (Stephens), *Choroterpes (Ch.) picteti* Eaton et *Choroterpes (Euthraulus)* ortali nov. sp. qui est décrite à tous les stades. De nouveaux critères pour distinguer les larves du sous-genre *Euthraulus* sont proposés. Une espèce de Palingeniidae a été découverte dans les collections du Bet Gordon Museum à Deganya: *Palingenia orientalis* Chopra dont la femelle est décrite pour la première fois. Cette espèce a disparu de la région concernée au début des années '50.

Des informations géographiques sont également données sur la distribution de ces espèces à l'intérieur et en dehors de l'aire d'étude, de même que certaines observations écologiques. Par exemple, l'émergence sous l'eau est signalée pour la première fois dans le genre *Afronurus*.

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