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A Study on the Odonate Larvae of Turkish Thrace: with Larval Identification Keys to the Considered Taxa

Nurten HACET Belgin ÇAMUR-ELİPEK Timur KIRGIZ

Trakya University, Faculty of Science, Department of Biology, TR-22030 Edirne, TURKEY
e-mails: nhacet@hotmail.com; belgincamur@yahoo.com; timurk@trakya.edu.tr

ABSTRACT

The present paper focuses on odonate larvae (damselfly and dragonfly) within Turkish Thrace. A total of 26 spp. were recorded based on larval specimens collected from the region during sampling period between years 1982 and 2009. New localities for the odonate species, except *Caliaeschna microstigma*, *Gomphus flavipes, Cordulegaster insignis*, and *Sympetrum fonscolombii*, were added to their distributional ranges inside the region. Furthermore, *Anax imperator*, *Brachytron pratense*, and *Libellula fulva* were recorded from the provinces where they had not previously been found. Keys including illustrations of the larvae recorded in the region were provided.

Key words: Odonata, larvae, identification key, Turkish Thrace, Turkey.

INTRODUCTION

The larval records of the odonate species provide important data not only to prove that some migrant species could reproduce in the sampled sites but also to record the odonate species, which, in their adult forms have not previously been recorded in those areas (Schmidt, 1985; Arlt, 1999; Hope, 2008).

The larvae and exuviae of some odonate species have been given from the Anatolian part of Turkey so far (Schneider, 1983, 1985; Verschuren *et al*., 1987; Busse, 1993; Seidenbusch, 1995a, b, c, d, e, f, 1999; Dijkstra & Kalkman, 2001; Kalkman *et al*., 2004a; Van Pelt, 2004; Hope, 2008). Although only a few larval records of Odonata have been reported from Turkish Thrace (Camur-Elipek, 2003; Hacet & Aktaç, 2008) there exist no study primarily focusing on odonate larvae in the region.

We therefore compiled our data on larval odonates obtained from Turkish Thrace during a longterm field survey to contribute to missing data on the subject and update the distributional ranges of species identified based on larval specimens collected. In addition, larval keys to the species recorded during the study were arranged.

MATERIAL AND METHODS

In this study, the material collected by second and third authors during hydrobiological field studies carried out in Turkish Thrace between the years 1982 and

2009 was evaluated. Collecting localities were listed in chronological order for each province in the region. The studies of Carchini (1983), Askew (1988), Butler (1993, 1998), Hagen (1996), Seidenbusch (1996a, b), Suhling & Müller (1996), Norling & Sahlen (1997), Heidemann & Seidenbusch (2002), and Seidenbusch & Heidemann (2007) were used for species identifications. Larval identification keys to the considered taxa in the region were prepared based on larval and some exuvial features, and illustrations belonging to the specimens were given in Figures 1-39.

Although the species *Epallage fatime* (Charpentier, 1840) belonging to the family Euphaeidae is known from the study region, we could not find its larval specimens in the sampling localities in the region. So, an *E. fatime* specimen collected from Adana province (03.VII.2001, female) by third author was added to the key. Thus, it was provided the larval identification key to all odonate families which are known from Turkish Thrace.

Some general morphological features, including dragonfly and damselfly sexual characters, used for identification of odonate larvae were given in Figures 1-6.

Material collected is kept in the collection of the Biology Department of Trakya University, Edirne, Turkey (TUBM-ODO).

Collecting sites of larval odonate specimens in Turkish Thrace

Edirne province: (1) The Balkan Campus of Trakya University (brook), 22.IV.1982, 30.III.1986, 13.V.1989, 18.II.1994, 12.XI.1995, 15.V.1996, 28.V.1997, 09.V.2005, 09.VI.2006, 28.V.2009, 01.VI.2009; (2) Değirmenyeni village (trough), 18.VII.1986; (3) Süloğlu (brook under the dam), 21.IX.1986, 25.V.1987, 13.V.1996; (4) Enez- Lake Gala, 26.IX.1986, 29.IX.1986; (5) Demirhanlı village (brook), 25.V.1987; (6) Hasanağa village (brook), 30.V.1989; (7) Sarayiçi (Tunca River), 02.V.1991, 25.III.1995, 29.IV.1995, 27.V.1995, 30.IX.1995, 24.XII.1995; (8) Uzunköprü- Çöpköy village (pond), 13.VIII.1991; (9) Suakacağı village (Tunca River), 25.III.1995, 30.IX.1995, 20.XII.1995, 20.III.1996; (10) Değirmenyeni village (Tunca River), 25.III.1995, 27.V.1995, 28.X.1995; (11) Gazimihal Bridge (Tunca River), 30.IV.1995, 28.V.1995, 13.III.1996; (12) Bülbül island (Tunca River), 30.IV.1995, 25.X.1995; (13) Musabeyli village (pond), 13.V.1996, 24.V.2002; (14) Havsa- Hasköy village (pond near Gültaş Milk Factory), 29.VI.1996; (15) İskender village (brook), 29.VI.1996; (16) Uzunköprü (Kadıköy brook), 30.VIII.1996; (17) Keşan- Maltepe village (trough and pond), 30.VIII.1996; (18) Keşan- Mahmutköy village (brook), 30.VIII.1996; (19) Keşan- between Kılıçköy and Karahisar (brook), 31.VIII.1996; (20) Lalapaşa- Hamzabeyli village (pond), 04.VII.2001.

İstanbul province: (21) Lake Büyükçekmece, 27.IX.1997; (22) Menekşe Brook, 27.IX.1997; (23) Kısırmandıra area (pond near Miltaş coal mine), 28.IX.1997; (24) Çatalca-Oklalı village (trough), 28.IX.1997.

Kırklareli province: (25) Dereköy village (trough), 25.IV.1986; (26) Çağlayan stream, 10.VI.1987; (27) Pehlivanköy-Akarca village (pond), 02.III.1991; (28) Kavaklı village (brook), 03.VI.1994; (29) Pehlivanköy town (brook), 12.VII.1996; (30) Babaeski town (brook), 21.IX.1996; (31) Demirköy- Dupnisa cave area (brook), 18.X.1996; (32)

between Dereköy and Armutveren villages (brook), 18.X.1996; (33) Dereköy village (Bizim Pond), 18.X.1996; (34) between Ürünlü village and Kırklareli, 3rd km (brook), 02.XI.1996; (35) Demirköy town (brook near Trout foundation), 02.XI.1996; (36) between Demirköy and Sivriler village (brook under bridge), 02.XI.1996; (37) Arizbaba village (brook), 02.XI.1996; (38) between Üsküpdere and Kaynarca village (brook), 02.XI.1996; (39) Demirköy- Lake Erikli, 15.III.1999; (40) Demirköy- Lake Hamam, 15.III.1999; (41) Demirköy- Bulanıkdere (stream), 17.VI.2007; (42) Demirköy (Asker Brook), 17.VI.2007; (43) Demirköy- Lake Mert, 10.XI.2007.

Tekirdağ province: (44) Hayrabolu- Lahana village (brook), 24.VI.1986; (45) Marmara Ereğlisi- Sultanköy village (Kınık Brook), 17.VIII.1996; (46) Muratlı- Yurtbekler village (trough), 21.IX.1996; (47) Hayrabolu- Kandamış village (brook under bridge), 21.IX.1996.

RESULTS

The larvae of 26 odonate species belonging to 9 families were recorded from the Turkish Thrace, and taxonomic notes for some of the species were given in this section.

CALOPTERYGIDAE

Calopteryx virgo (Linnaeus, 1758)

Material Examined: Loc.1, 01.VI.2009, 1 male; Loc.35, 1 male; Loc.36, 1 female; Loc.37, 1 female; Loc.41, 1 female.

Comments: *C. virgo* can be distinguished from *Calopteryx splendens* especially by its stronger occipital and pronotal processes (Carchini, 1983; Norling & Sahlen, 1997). Our specimens have distinct processes behind eyes and on the front margin of pronotum (Fig. 7a). Furthermore, larval specimens of this species were found in clear and fast running waters in woodland, forming its typical habitat (Askew, 1988).

LESTIDAE

Lestes barbarus (Fabricius, 1798)

Material Examined: Loc.3, 25.V.1987, 1 male; Loc.5, 3 males, 2 females; Loc.13, 13.V.1996, 1 male, 1 female.

Comments: Present specimens have characters indicated for *L. barbarus* by Heidemann & Seidenbusch (2002). The tips of caudal gills of this species are long and narrow, and terminate in a small point. Their margins in our specimens are nearly straight at tips (Fig. 11a). In addition, the distal margins of caudal gills may be also slightly concave as indicated by Heidemann & Seidenbusch (2002).

Chalcolestes cf. *parvidens* (Artobolevsky, 1929)

Material Examined: Loc.14, 1 female; Loc.28, 1 female.

Comments: *C. parvidens* and *Chalcolestes viridis* are known from Bulgaria and Greece (Olias *et al*., 2007). *C. parvidens* has been so far recorded from many localities in Turkish Thrace (Kempny, 1908; Yazıcıoğlu, 1982; Havza & Aktaç, 1987; Hacet & Aktaç, 1997, 2004). Recently, Olias *et al*. (2007) argued that the occurrence

of both *C. parvidens* and *C. viridis* syntopically in some localities of Turkish Thrace should not be excluded. Characteristics belonging only to larval *C. viridis* are given in the studies of Askew (1988) and Heidemann & Seidenbusch (2002). According to available data, the larval differentiation between *C. parvidens* and *C. viridis* is not clear. The front branches close to the movable hooks of labial palps in our specimens are finely crenated in distal (Fig. 9b) and the caudal gills are rounded at the tips (Fig. 11b). Considering the wide distribution of *C. parvidens* in the study region, the larval specimens collected belong most probably to *C. parvidens.*

COENAGRIONIDAE

Coenagrion puella (Linnaeus, 1758)

Material Examined: Loc.1, 28.V.2009, 1 female; Loc.33, 1 male, 1 female; Loc.46, 1 female.

Comments: *C. puella* and *Coenagrion pulchellum* both have 7-segmented antennae within the genus (Fig. 14). Nodal lines on their procts extend upright to longitudinal axis and are curved (Figs. 16a, b). The shapes of procts at the tip were reported as a character that could be used to separate the two species but despite, this character was argued to be an unreliable one (Carchini, 1983; Askew, 1988; Norling & Sahlen, 1997). Procts at apex are pointed in *puella* (Fig. 16a), but are rounded in *pulchellum* (Fig. 16b).

Some useful characters for the separation of exuviae of *C. puella* and *C. pulchellum* species were suggested by Seidenbusch (1996a). The angle between two oblique rows of setae on pressed mentum and the shapes of lateral bumps of articulations in distal of mentum in our specimens match those given for exuvial identification of *C. puella* by Seidenbusch (1996a) and were given in the key for the seperation of these two species in this study.

Coenagrion cf. *pulchellum* (Vander Linden, 1825)

Material Examined: Loc.39, 1 male.

Comments: Mentum features of our specimen seem to resemble the features suggested by Seidenbusch (1996a) for *C. pulchellum* (Fig. 13c). However, more material from the locality is needed.

Erythromma lindenii (Selys, 1840)

Material Examined: Loc.1, 09.VI.2006, 1 male; Loc.13, 13.V.1996, 2 males, 6 females.

Comments: Seidenbusch (1997) indicated, in a comparison to the exuvial specimens of *Erythromma lindenii and Erythromma viridulum*, that spines on lateral margin of the mentum exceed the level of the last mental setae in *E. lindenii* but reach to their level in *E. viridulum.* These features are also seen in larval specimens of *E. lindenii* and *E. viridulum* identified in our present study.

Erythromma viridulum (Charpentier, 1840)

Material Examined: Loc.13, 13.V.1996, 6 males, 10 females.

Ischnura elegans (Vander Linden, 1820)

Material Examined: Loc.1, 09.V.2005, 1 male, 1 female, –28.V.2009, 1 female; Loc.7, 02.V.1991, 1

male, 2 females; Loc.8, 2 females; Loc.13, 13.V.1996, 1 female, –24.V.2002, 1 male; Loc.19, 1 male; Loc.27, 1 male; Loc.38, 1 female; Loc.39, 2 males; Loc.40, 1 female; Loc.45, 1 female.

Comments: The shape of procts and the number of setae on labial palps in recorded larval specimens match with those of given for *I. elegans* by Carchini (1983), Askew (1988), and Norling & Sahlen (1997). Procts are long, slender and pointed-shaped at the apical (Fig. 16e). Our specimens have generally six setae on labial palps and only a few have five setae (Fig. 13a).

PLATYCNEMIDIDAE

Platycnemis pennipes (Pallas, 1771)

Material Examined: Loc.1, 15.V.1996, 1 male; Loc.2, 1 male; Loc.4, 29.IX.1986, 1 female; Loc.6, 1 male; Loc.9, 20.III.1996, 1 male; Loc.11, 30.IV.1995, 1 female, –13.III.1996, 1 male; Loc.15, 1 male; Loc.17, 1 male; Loc.24, 1 male; Loc.30, 1 female; Loc.34, 1 male; Loc.47, 1 male.

Comments: The family Platycnemididae in the Turkish Thrace is represented only by the species *P. pennipes* (Hacet & Aktaç, 2004).

AESHNIDAE

Anax imperator Leach, 1815

Material Examined: Loc.1, 30.III.1986, 1 female; Loc.3, 21.IX.1986, 1 male; Loc.8, 1 male; Loc.23, 1 male; Loc.25, 1 female; Loc.44, 1 male.

Comments: A comparison of characters used in separation of the exuviae of two species whose larvae resemble to each other (*A. imperator* and *Anax parthenope*) was given by Hagen (1996). Basal projection on epiproct in males, ovipositor in females and premental shape in both sexes are considered as useful features to distinguish *A. imperator* from other species. Biometrical measurements of these characters in our larval specimens match those given for *A. imperator* by Hagen (1996).

Brachytron pratense (Müller, 1764)

Material Examined: Loc.44, 1 female.

Caliaeschna microstigma (Schneider, 1845)

Material Examined: Loc.1, 22.IV.1982, 1 female, –28.05.1997, 1 male, –01.VI.2009, 2 males.

GOMPHIDAE

Gomphus flavipes (Charpentier, 1825)

Material Examined: Loc.7, 29.IV.1995, 1 male, 1 female, –27.V.1995, 1 male, 1 female, –30.IX.1995, 1 female, –24.XII.1995, 1 female; Loc.9, 20.XII.1995, 1 male.

Comments: There is a short spine on posterior margin of 9th abdominal segment (Fig. 27a). This spine is smaller or rudimentary in the related species, *Gomphus ubadschii* present in Anatolia (R. Seidenbusch, pers. comm.).

Gomphus vulgatissimus (Linnaeus, 1758)

Material Examined: Loc.9, 25.III.1995, 1 female, –30.IX.1995, 2 females; Loc.31, 1 male.

***Onychogomphus forcipatus* (Linnaeus, 1758)**

Material Examined: Loc.1, 22.IV.1982, 1 female; Loc.26, 2 males, 1 female; Loc.41, 4 males, 4 females.

Comments: The numbers of lateral and dorsal spines on the abdominal segments in our material seem to fit those given for the nominate subspecies by Suhling & Müller (1996). Lateral spines are present on 6th to 9th abdominal segments (Fig. 28a). There are dorsal spines on 2nd to 9th abdominal segments, among which 5th and 6th are less prominent (Fig. 28b).

CORDULIIDAE

***Somatochlora* cf. *meridionalis* Nielsen, 1935**

Material Examined: Loc.42, 1 male.

Comments: *S. meridionalis* has an evident dorsal hook on its 9th abdominal segment (Figs. 31e, f) which is not present or is in a very small tooth-shape in *Cordulia aenea*, which is a species of another genus belonging to Corduliidae known from Turkey (Heidemann & Seidenbusch, 2002; Fleck *et al*., 2007). The differentiation of exuviae of two related species, *S. meridionalis* and *Somatochlora metallica*, was given by Seidenbusch (1996b) and Fleck *et al*. (2007). In our present specimen, there is a straight and evident hook on the 3rd abdominal segment. Lateral spine on the 9th abdominal segment is longer than that of 8th segment (Fig. 31e). In contrast to the weak tubercules on occiput in exuviae, our specimen, which is a young Corduliid larva, has distinctly two evident tubercules on its occiput as indicated for the young larva of *S. metallica* in the study of Norling & Sahlen (1997) (Fig. 31a). Taking into consideration the distribution of *S. meridionalis* in Turkish Thrace and morphological features of the larval specimen, our present larval specimen most probably belongs to *S. meridionalis.*

CORDULEGASTRIDAE

***Cordulegaster insignis* Schneider, 1845**

Material Examined: Loc.1, 22.IV.1982, 1 male, –09.V.2005, 1 male, –01.VI. 2009, 1 male.

Comments: Biometrical data of some useful characters used in the separation of the larvae of West-Palaearctic *Cordulegaster* species are given in the study of Verschuren (1989). The ratio of head width to prothorax width, and the ratios of the lengths of prementum and paraprocts to their widths in our specimens are inside the limits of measurements reported for *C. insignis* by Verschuren (1989).

***Cordulegaster picta* Selys, 1854**

Material Examined: Loc.41, 1 female.

Comments: *Cordulegaster picta* is placed in *Cordulegaster boltoni* group of West-Palaearctic *Cordulegaster* taxa. *C. boltoni* group is divided into two subgroups, which are different in the ratio of head and prothorax and the length and width ratio of paraprocts (Verschuren, 1989). Our present specimen belongs to the subgroup of eastern taxa of them. Width ratio of head and prothorax is less than 1.25, and the ratio of the lengths of paraprocts to their widths is less than 1.20.

***Cordulegaster* sp.**

Material Examined**:** Loc.20, 1 male; Loc.32, 1 male.

Comments: The present specimens are belonging to *C. boltoni* /*heros-picta*/ groups given in the key.

LIBELLULIDAE

***Libellula depressa* Linnaeus, 1758**

Material Examined: Loc.1, 22.IV.1982, 1 female, –13.V.1989, 1 male; Loc.3, 21.IX.1986, 1 male; Loc.25, 1 male, 3 females; Loc.46, 1 male.

***Libellula fulva* Müller, 1764**

Material Examined: Loc.1, 18.II.1994, 1 male; Loc.16, 1 male; Loc.22, 1 male.

***Orthetrum albistylum* (Selys, 1848)**

Material Examined: Loc.7, 02.V.1991, 7 males, –25.III.1995, 1 male; Loc.10, 25.III.1995, 1 female, –27.V.1995, 1 female, –28.X.1995, 1 female; Loc.11, 28.V.1995, 1 male; Loc.12, 30.IV.1995, 1 male, –25.X.1995, 1 male; Loc.13, 24.V.2002, 1 male; Loc.18, 1 male.

***Orthetrum brunneum* (Fonscolombe, 1837)**

Material Examined: Loc.1, 28.V.1997, 1 male; Loc.3, 13.V.1996, 1 male; Loc.18, 1 male; Loc.21, 1 male; Loc.29, 2 males.

***Orthetrum cancellatum* (Linnaeus, 1758)**

Material Examined: Loc.1, 12.XI.1995, 1 male; Loc.4, 26.IX.1986, 1 male, 1 female; Loc.16, 1 male; Loc.43, 1 male.

***Orthetrum coerulescens* (Fabricius, 1798)**

Material Examined: Loc.1, 28.V.1997, 1 male.

***Sympetrum fonscolombii* (Selys, 1840)**

Material Examined: Loc.3, 21.IX.1986, 2 males.

Comments: There is no dorsal spine on abdominal segments of larvae of *Sympetrum fonscolombii* (Fig. 39c) and *Crocothemis* spp. (Carchini, 1983). These taxa have lateral spines that are almost the same length on 8th and 9th abdominal segments (Seidenbusch & Heidemann, 2007). *S. fonscolombii* is different from *Crocothemis* spp. with its S8 sternite without a setae-crest (Carchini,1983; Seidenbusch & Heidemann, 2007). *S. fonscolombii* and *Crocothemis* spp. can also be distinguished from each other by the number of mesosternal setae, a new distinctive feature presented by Seidenbusch & Heidemann (2007). The number of mesosternal setae in exuvial specimens is two in *S. fonscolombii* differing from the latter with 6-10 setae. The collected larval specimens have also two mesosternal setae and there are 12 to 14 setae on labial palps (Fig. 39b).

Key to suborders and families of the odonate larvae from Turkish Thrace

1- Body slender, with three leaf like caudal gills in terminal (Fig. 1) ..... ZYGOPTERA... 2

- Body robust, with five short appendages pointed in terminal (Fig. 2) ..... ANISOPTERA … 6

2- Abdominal segments with lateral gills (Fig. 8) ..... Euphaeidae

- Abdominal segments without lateral gills 3

3- First antennal segment longer than the total length of the remaining segments (Fig. 7c), or in the same length. Distal side of mentum with a lozenge-shaped cleft (Fig. 7b) .... Calopterygidae

- First antennal segment short (Fig. 10), mentum entire (Fig. 6) or with a short and narrow incision in its apical (Figs. 9a, b) 4

4- Labial palp with two branches because of a deep cleft in its distal side, setae present on movable hook (Fig. 9b); mentum with a short apical incision (Figs. 9a, b). Cerci long and pointed (Fig.11b)…….....Lestidae

- Labial palp without a deep cleft, only with shallow dentations in its distal side, no setae present on movable hook (Figs. 6, 13a); mentum without a median incision in apical (Figs. 6, 13a). Cerci short and robust (Fig. 16e) .....…5

5- Labial palps with 2-4 long setae on their lateral margins; mentum with 2 or 4 setae placed in a straight transverse row (Fig. 6). Caudal gills carry a long attenuation at tip and their main tracheas with angled-bump (Fig. 17).....Platycnemididae

- Labial palps with 5-7 long setae on their lateral margins; mentum with more than 2 long setae placed in two oblique rows, close each other in basal (Fig. 13a). Main tracheas of caudal gills without angled-bump (Figs. 16a, b, c, d, e) .....Coenagrionidae

6- Mentum flat in lateral view (Fig. 23a). Labial palps narrow (Figs. 24a, b) 7

- Mentum spoon-shaped in lateral view (Fig. 32b). Labial palps triangular (Figs. 29a, b, 31b, 33a, c, 36a, b, c, d, 39b) 8

7- Antennae with 6-7 segments normally, filament-shaped; segments similar to each other (Fig. 20) ……..…….....…….……..……Aeshnidae

- Antennae with 4 segments; segments different from each other in length and width (Figs. 25a, b) …..……..……..……..Gomphidae

8- Distal margins of labial palps with deep and irregular–shaped dentations (Figs. 29a, b) .....Cordulegastridae

- Distal margins of labial palps without deep and irregular dentations (Figs. 31b, 33a, c, 36a, b, c, d, 39b) 9

9- Distal margins of labial palps with deep and asymmetrical crenations (Fig. 31b). Femurs of long and thin legs with few hard setae (Fig. 31d). Cercus more than half-length of paraproct in exuvia. .....Corduliidae*

- Distal margins of labial palps with shallow crenations (Figs. 36a, b, c, d); or if they have deep and asymmetrical crenations (Fig. 33a), the femurs of short legs have long and soft hairs (Fig. 37). Cercus less than half-length of paraproct in exuvia. .....Libellulidae*

* Theischinger & Fleck (2003) considered a useful feature for the separation of two families, Corduliidae and Libellulidae. This character allows the separation of the larvae of Corduliid genera (except some *Macromia* and *Apocordulia*) and almost all Libellulid genera studied in several large faunal regions. There is predominantly a narrow medio-basal groove on the ventral face of mentum in Corduliid larvae (Fig. 31c). This structure is absent in most Libellulid (Fig. 33b), may be seen rarely, but weak or not homologous with groove in Corduliid (Theischinger & Fleck, 2003).

Keys to the genera and the species of the odonate larvae recorded from the Turkish Thrace

A. Key to genera of Lestidae

1- Mentum with long-stalk, and spoon-shape. Labial palp: distal comb of palpus with an aboral and an adoral tooth (Fig. 9a) .....*Lestes*

- Mentum without stalk, and with triangle shape. Labial palp: distal comb of palpus without a aboral and an adoral tooth (Fig. 9b) .....*Chalcolestes*

B. Key to genera of Coenagrionidae

In all genera of Coenagrionidae given in the key, occiput rounded (Fig. 12a), *the eye with setae in its ventral margin* (Fig. 12b).

1- First abdominal sternite with hard setae (Figs. 15a, b) …….....*Erythromma*

- First abdominal sternite without setae...……..……..…2

2- Length and thickness of marginal spines on procts are different on both margins. Marginal spines extend at different distances throughout both margins (Fig. 16e). Generally spines on one margin extend at about 1/4-3/4 shorter distance than those of the other margin or never totally. If spines present throughout both margins, spines on one margin are shorter and thiner than those of the other margin.....*Ischnura*

- Length and thickness of marginal spines on procts are equal on both margins (Figs. 16a, b). (in exuvia: If length and thickness of marginal spines are not equal on both margins, the length of proct is 1/3 or 1/5 of body length).....*Coenagrion*

-Key to the species of *Coenagrion*

1- (in exuvia): Angle of the oblique rows of setae on pressed mentum wide (=100°) (Fig. 13c), and lateral bumps of articulations in distal of mentum upright tubercle shaped, and almost semicircular.....*C. pulchellum*

- (in exuvia): Angle of the oblique rows of setae on pressed mentum narrow (=80^0) (Fig. 13b), and lateral bumps of articulations in distal of mentum flatly curved.....*C. puella*

-Key to species of *Erythromma*

1- Poststernite of thorax with hard setae (Fig. 15a); procts rounded at apex (Fig. 16c). 3rd basisternite has not a cleft in exuvia.....*E. lindenii*

- Poststernite of thorax without hard setae (Fig. 15b); procts pointed at apex (Fig. 16d). 3rd basisternite has a cleft twisting towards inside body in exuvia.....*E. viridulum*

C. Key to genera and species of Aeshnidae

1- In dorsal view of head, eyes small; the length of lateral margin of eye shorter than occipital length; head with occipital margins tapering towards to its posterior corners (Fig. 18b). Lateral borders of mentum abruptly constricted basalwards (Fig. 19b). Anterior procoxal projection longer than posterior projection (Fig. 21b) .....*Brachytron*

(Basal margin of mentum with a cleft in middle (Fig. 19b). Distal margin of 9th abdominal segment with a mid-spine dorsally (Fig. 22a)…….....…….....*Brachytron pratense*)

- In dorsal view of head, eyes large; the length of lateral margin of eye as long as occipital margin or longer (Figs. 18a, c). Occipital margins relatively parallel. Mentum longer than broad (Figs. 19a, c). Supracoxal projections variable (Figs. 21a, c).....…...2

2- Epiproct with a single point at tip and a pointed supraanal tooth (Fig. 22b). Inside corner of hind margin of eye as a narrowed-part, hind margin of eye distinctly waved [like in *Aeshna*] (Fig. 18c). Distal margin of mentum with two glossae on median lobe of mentum (Fig. 19d). Lateral borders of mentum about conical narrowed basalwards (Fig. 19c).....
.....*Caliaeschna microstigma*)

- Epiproct bifid at tip (Fig. 5a). Hind margin of eye slightly concave, and extends parallel with

that of occiput (Fig. 18a). [also in *Aeshna isoceles*: hind margin of eye slightly parallel with that of occiput].....*Anax*

(The length of male projection on the epiproct nearly half as long as a cercus (Figs. 5a, b). Ratio of the length of female ovipositor to the length of 9th abdominal segment in exuvia, about 3/4 ..... *A. imperator*)

D. Key to genera of Gomphidae

1- Labial palp as a hook pointed at distal (Fig. 24a). 3rd antennal segment slender, and about as wide as 2nd segment (Fig. 25a). There are no protruding lateroscapal lobes of frons…….....*Gomphus*

- Labial palp without a distal hook, but rounded at tip (Fig. 24b). 3rd antennal segment flattened and wider than 2nd segment (Fig. 25b). Lateroscapal lobes of frons distinctly protruding (Fig. 23b).....*Onychogomphus*

-Key to species of *Gomphus*

1- Front tibiae with small borrowing hooks (Fig. 26a), middle tibiae without hooks in its distal .....*G. flavipes*

- Front and middle tibiae with conspicuous borrowing hooks in their distals (Fig. 26b). S6-9 with lateral spines. S9 distinctly narrowed towards its end (Fig. 27b).....*G. vulgatissimus*

E. Key to genera of Cordulegastridae

The family Cordulegastridae is represented by the genus C*ordulegaster*.

-Key to species of *Cordulegaster*

1- S8 (small or missing) and S9 with lateral spines (Fig. 30b), length and width ratio of prementum more than 1.05.....*C. boltoni* /*heros-picta*/ groups

[mentum with 6 long setae; labial palp with 5 long setae (Fig. 29b)….....*C. picta*]

- S8-9 without lateral spines (Fig. 30a), length and width ratio of prementum less than 1.05..... .....*C. bidentatus*/*insignis* groups

[mentum with 4 long setae; labial palps with 3 or 4 setae (Fig. 29a) .....*C. insignis*]

F. Key to genera of Libellulidae

1- Lateral borders of occiput behind eyes parallel to each other in dorsal view, and at least twice of vertical length of eye (Fig. 32a)…….....2

- Lateral borders of occiput behind eyes narrowed towards posterior corners, and rounded at the corners (Fig. 39a), and vertical length of eye hardly half of the vertical length of head in dorsal view, (in exuvia: cerci the most half as long as paraprocts) (Fig. 39c).....*Sympetrum*

2- S7 without dorsal spine (Figs. 38a, b, c, d) ….....*Orthetrum*

- S7 with dorsal spine (Figs. 34a, b).....*Libellula*

-Key to species of *Libellula*

1 - S9 without dorsal spine (Fig. 34a). Distal margin of labial palp with deep and asymmetric crenations (Fig. 33a). Labial palp with 10/12 setae in exuviae…….....*L. depressa*

- S9 with dorsal spine (Fig. 34b). Distal margin of labial palp with shallow and symmetric crenations (Fig. 33c). Labial palp with 4/5 setae in exuviae.....*L. fulva*

-Key to species of *Orthetrum*

1- Dorsal spines present on abdomen (Fig. 38c), (cerci shorter than half-length of epiproct in exuvia).....*O. cancellatum*

- Dorsal spines absent on abdomen (Figs. 38 a, b, d).....2

2- Mentum with an evident scalloped margin at distal lobe (Fig. 36a). Setae between the crenations clear (Fig. 35a), and their lengths more than half-width of the last crenation in exuvia. Labial palp with 4-5 setae (Fig. 36a) ..... *O. albistylum*

- Mentum with a shallow scalloped margin at distal lobe (Figs. 36b, d). Setae between the crenations very short or absent (Figs. 35b, c). Labial palps with 3-6 setae (Figs. 36b, d)……3

3- Labial palp with 6 setae, mentum with 3 long setae in one row of setae (Fig. 36b)..... .....*O. brunneum*

- Labial palp with 3 or 4 setae, mentum with 2 long setae in one row of setae (Fig. 36d)..... .....*O. coerulescens*

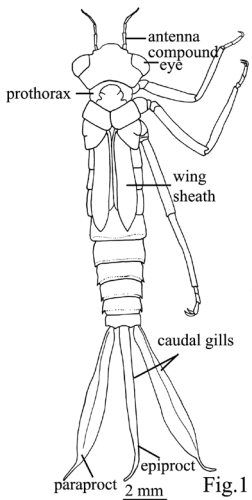


Fig.1

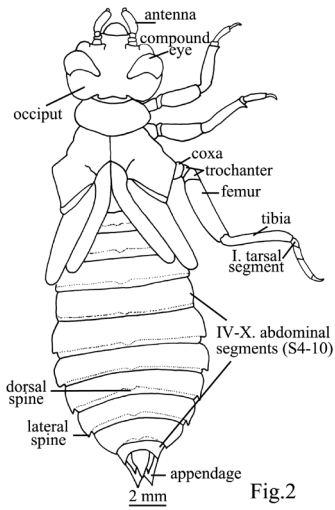


Fig.2

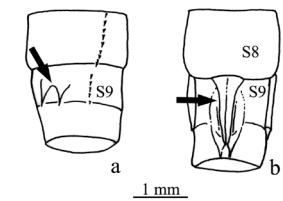


Fig.3

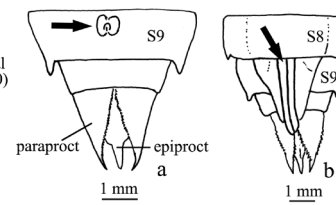


Fig.4

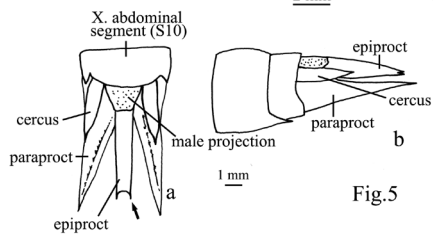


Fig.5

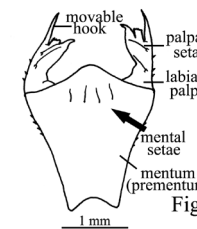
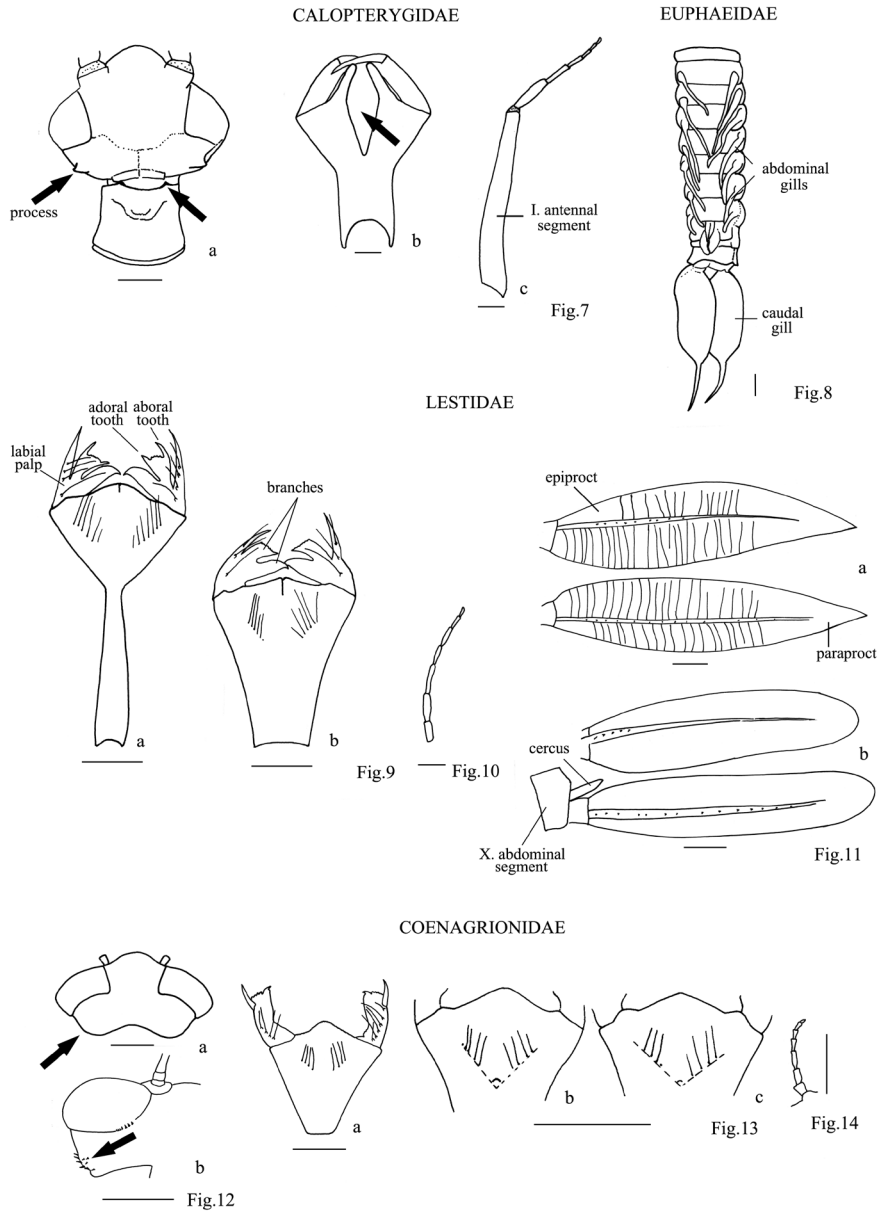
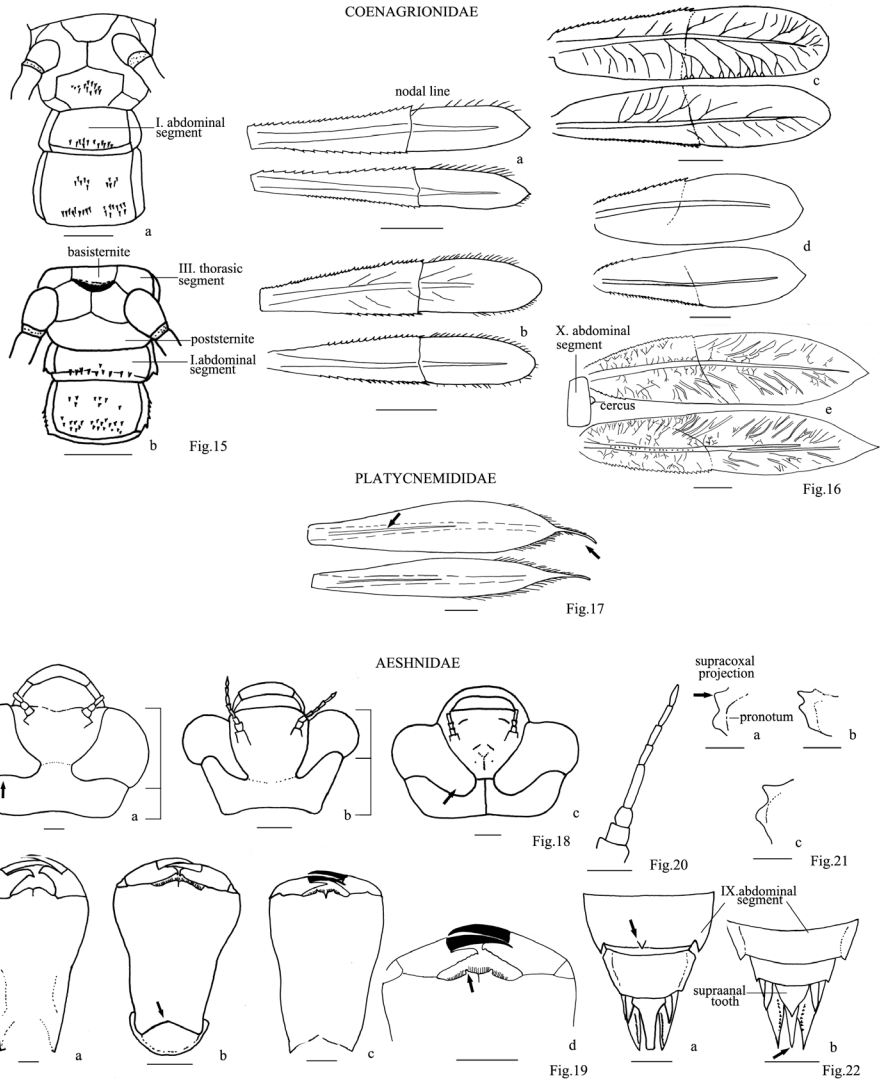


Fig.6

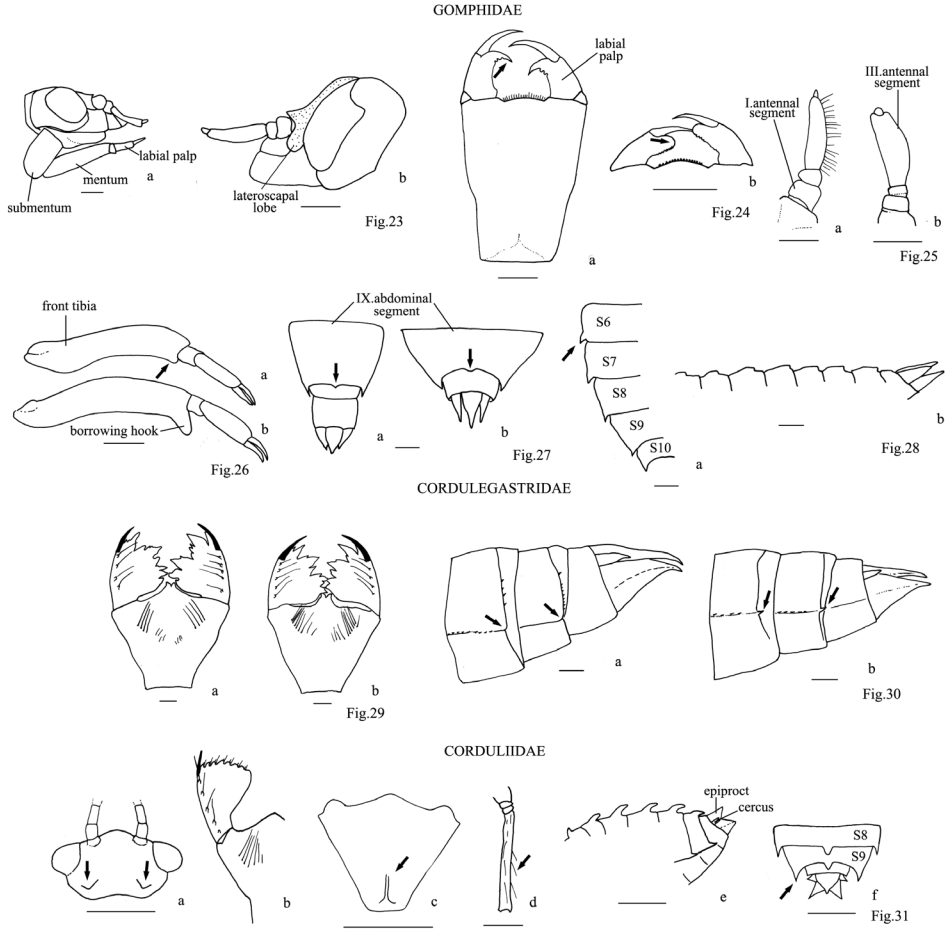
Figs. 1-6. Fig. 1- Zygopteran larva (*Platycnemis pennipes*) (dv). Fig. 2- Anisopteran larva (*Onychogomphus forcipatus*) (dv). Fig. 3- Zygoptera (*Erythromma lindenii*): a. valvulae in male (vv); b. gonapophyses in female (vv). Fig. 4- Anisoptera (*Caliaeschna microstigma*): a. valvulae and gonapore in male (vv); b. gonapophyses in female (vv). Fig. 5- projection on epiproct in *Anax imperator* (male): a. (dv); b. (lv). Fig. 6- mentum in *Platycnemis pennipes* (iv). [abbreviations- (dv): dorsal view; (vv): ventral view; (lv): lateral view, (iv): internal view].



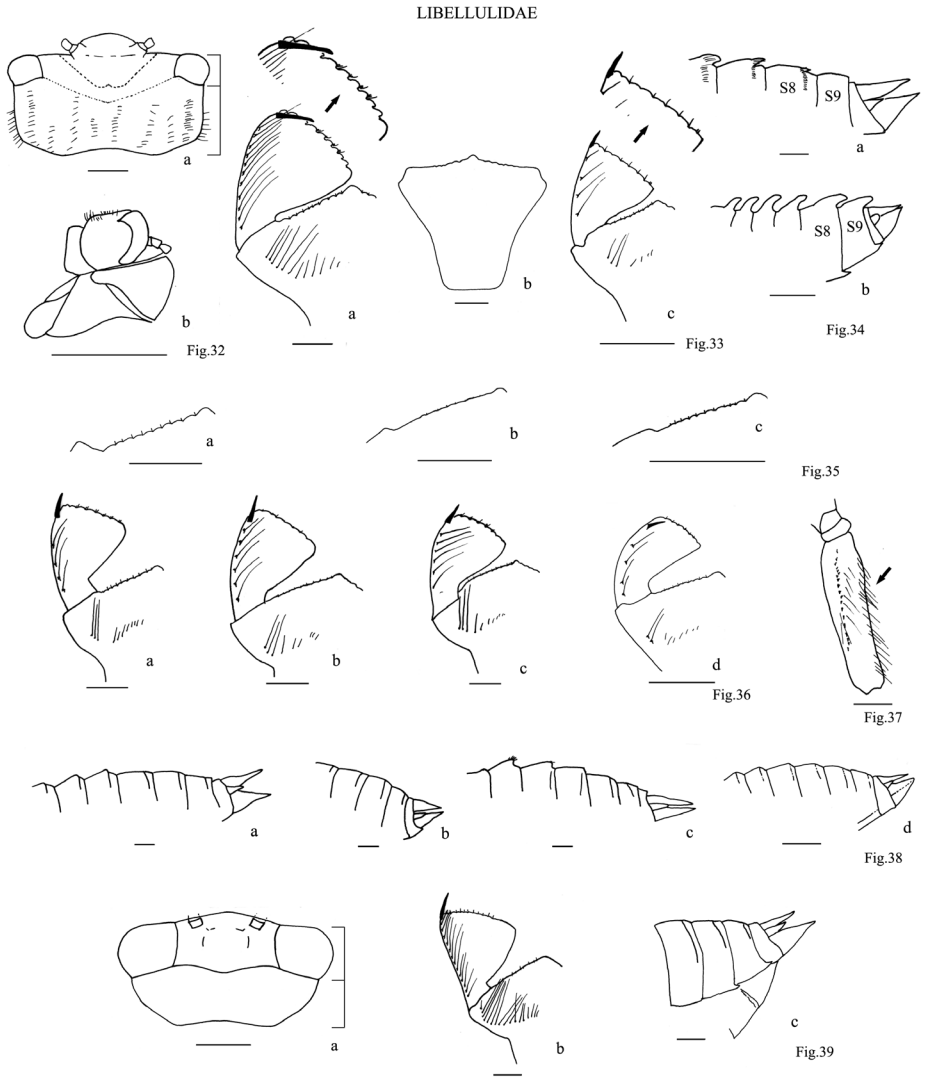
Figs. 7-14. Fig.7- *Calopteryx virgo*: a. head (dv); b. mentum (vv); c. antenna. Fig. 8- abdominal gills in *Epallage fatime* (vv). Fig. 9- mentum (iv): a. *Lestes barbarus*; b. *Chalcolestes* cf. *parvidens*. Fig. 10- antenna in *C.* cf. *parvidens*. Fig. 11- caudal gills: a. *L. barbarus*; b. *C.* cf. *parvidens*. Fig. 12- head: a. *Erythromma lindenii* (dv); b. *Ischnura elegans* (vv). Fig. 13- mentum (iv): a. *I. elegans*; b. *Coenagrion puella*; c. *C.* cf. *pulchellum*. Fig. 14- antenna in *C. puella*. -[scales= 1 mm]. [abbreviations: (dv): dorsal view; (vv): ventral view; (iv): internal view].



Figs. 15-22. Fig.15- metathorax and first abdominal segment (vv): a. *Erythromma lindenii*; b. *E. viridulum*. Fig.16- caudal gills: a. *Coenagrion puella*; b. *C.* cf. *pulchellum*; c. *E. lindenii*; d. *E. viridulum*; e. *Ischnura elegans*. Fig.17- caudal gills in *Platycnemis pennipes*. Fig.18- head (dv): a. *Anax imperator*; b. *Brachytron pratense*; c. *Caliaeschna microstigma*. Fig.19- mentum (vv): a. *A. imperator*; b. *B. pratense*; c. *C. microstigma*; d. glossae on median lobe of mentum in *C. microstigma*. Fig.20- antenna in *A. imperator*. Fig.21- supracoxal projection: a. *A. imperator*; b. *B. pratense*; c. *C. microstigma*. Fig.22- S9-10 (dv): a. *B. pratense*; b. *C. microstigma*. -[scales= 1 mm]. [abbreviations- (dv): dorsal view; (vv): ventral view; (iv): internal view; (S): abdominal segment].



Figs. 23-31. Fig.23- head (lv): a. *Gomphus flavipes*; b. *Onychogomphus forcipatus*. Fig.24- mentum (vv): a. *G. flavipes*; b. *O. forcipatus*. Fig.25- antenna: a. *G. flavipes*; b. *O. forcipatus*. Fig.26- front tibia: a. *G. flavipes*; b. *G. vulgatissimus*. Fig.27- S9-10 (dv): a. *G. flavipes*; b. *G. vulgatissimus*. Fig.28- *O. forcipatus:* a. lateral spines on S6-10 (dv); b. dorsal spines on S3-10 (lv). Fig.29- mentum (iv): a. *Cordulegaster insignis*; b. *C. picta*. Fig.30- S8-10 (lv): a. *C. insignis*; b. *C. picta*. Fig.31- *Somatochlora* cf. *meridionalis*: a. head (dv); b. mentum and left labial palp (iv); c. mentum (vv); d. setae on femur; e. dorsal and lateral spines on abdominal segments (lv); f. lateral spines on S8-9 (dv). -[scales= 1 mm]. [abbreviations- (dv): dorsal view; (vv): ventral view; (lv): lateral view; (iv): internal view; (S): abdominal segment].



Figs. 32-39. Fig.32- head in *Libellula depressa*: a. (dv); b. (lv). Fig.33- mentum and labial palp: a. *L. depressa* (iv); b. *L. depressa* (vv); c. *L. fulva* (iv). Fig.34- abdominal segments (lv): a. *L. depressa*; b. *L. fulva*. Fig.35- folds and setae on the distal margin of median lobe of mentum (iv): a. *Orthetrum albistylum*; b. *O. brunneum*; c. *O. coerulescens*. Fig.36- mentum and left labial palp: a. *O. albistylum*; b. *O. brunneum*; c. *O. cancellatum*; d. *O. coerulescens*. Fig.37- setae on femur in *O. brunneum*. Fig.38- abdominal segments (lv): a. *O. albistylum*; b. *O. brunneum*; c. *O. cancellatum*; d. *O. coerulescens*. Fig.39- *Sympetrum fonscolombii*: a. head (dv); b. mentum and left labial palp (iv); c. last abdominal segments (lv). -[scales= 1 mm]. [abbreviations- (dv): dorsal view; (vv): ventral view; (lv): lateral view; (iv): internal view].

DISCUSSION

A total of 53 Odonate species based on adult identifications have been reported from Turkish Thrace so far (Yazıcıoğlu, 1982; Hacet & Aktaç, 1994, 1997, 2004, 2008; Boudot *et al*., 2004). Of them, larvae of 26 species were recorded from the study region in this paper.

Most of the collecting sites given in the present paper are new localities for the distributional ranges of the recorded larval species except *Caliaeschna microstigma*, *Gomphus flavipes*, *Cordulegaster insignis* and *Sympetrum fonscolombii*. Furthermore, taking into consideration that *Coenagrion* cf. *pulchellum*, *Anax imperator*, *Brachytron pratense* and *Libellula fulva* have been recorded in some provinces of Turkish Thrace, we have established new records from other provinces in the region.

Coenagrion cf. *pulchellum* is known from only two localities in İstanbul province in Turkish Thrace (Hacet & Aktaç, 1994). Adults of *C. pulchellum* were also recorded from Edirne province in the region by the first author (Hacet, unpublished data). The locality where the larva of this species was found is situated between Edirne and İstanbul provinces at the north of the region. The habitat of this locality is composed of a lake with marshy bank. Considering both the localities where *C*. cf. *pulchellum* was recorded in the region, and its typical habitat where it was recorded in the region, this species is likely to occur in this locality.

Although *Anax imperator* was reported from Turkish Thrace in Edirne, Kırklareli and İstanbul provinces (Spagnolini, 1877; Hacet & Aktaç, 1997, 2004; Camur-Elipek, 2003), it was recorded within this study from new localities in these provinces as well as from a new province (Tekirdağ) in the region.

Brachytron pratense has been so far reported only from five provinces (Kırklareli, İstanbul, Balıkesir, Afyon and Muğla) in the western part of Turkey (Morton, 1915; Hacet & Aktaç, 1997; Van Pelt, 2004; Kalkman *et al*., 2004b; Hope, 2007). We found the larval specimen of *B. pratense* from a new province (Tekirdağ) in Turkish Thrace.

The known distributional range of *Libellula fulva* in Turkish Thrace includes Edirne, Kırklareli and Tekirdağ provinces (Hacet & Aktaç, 1997, 2004). In this study, a new province (İstanbul) was added to its distributional range in the region.

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REFERENCES

Arlt, J., 1999, Entwicklungsnachweis von *Pantala flavescens* (Fabricius) in der Türkei (Anisoptera: Libellulidae). *Libellula*, 18: 95-96.

Askew, R. R., 1988, *The Dragonflies of Europe*. Harley Books, Colchester, 291pp.

Boudot, J.-P., Grand, D., Grebe, B., Hacet, N., Marinov, M., 2004, Description of the female of *Somatochlora borisi* with distributional notes on the species (Odonata: Corduliidae). *International Journal of Odonatology,* 7: 431-438.

Busse, R., 1993, Libellen von der türkischen Südküste. *Libellula*, 12: 39-46.

Butler, S. G., 1993, Key to the larvae of European *Orthetrum* Newman (Anisoptera: Libellulidae). *Odonatologica*, 22: 191-196.

Butler, S. G., 1998, The larvae of the European Aeshnidae (Anisoptera). *Odonatologica*, 27: 1-23.

Camur-Elipek, B., 2003, The dynamics of Benthic macroinvertebrates in a mesotophic lake: Terkos, Turkey. *Acta biologica iugoslavica –serija D: Ekologija*, 38: 31-40.

Carchini, G., 1983, A key to the Italian Odonate Larvae. *Societas Internationalis Odonatologica Rapid Communications* (Supplements), 1: 101pp.

Dijkstra, K.-D. B., Kalkman, V. J., 2001, Early spring records of Odonata from southern Turkey, with special reference to the sympatric occurrence of *Crocothemis erythraea* (Brullé) and *C. servilia* (Drury) (Anisoptera: Libellulidae). *Notulae odonatologicae*, 5: 85-88.

Fleck, G., Grand, D., Boudot, J.-P., 2007, Description of the last stadium larva of *Somatochlora borisi*, with comparison to that of *Somatochlora metallica meridionalis* (Odonata: Corduliidae). *International Journal of Odonatology*, 10: 43-52.

Hacet, N., Aktaç, N., 1994, Trakya Bölgesi Odonata Faunasına Yeni Kayıtlar. *XII. Ulusal Biyoloji Kongresi, 6-8 Temmuz,* Edirne. pp.202-209.

Hacet, N., Aktaç, N., 1997, Istranca Dağları Odonata faunası [Odonata fauna of Istranca Mountains]. *Turkish Journal of Zoology*, 21: 275-289.

Hacet, N., Aktaç, N., 2004, Considerations on the odonate fauna of Turkish Thrace, with some taxonomic notes. *Odonatologica*, 33: 253-270.

Hacet, N., Aktaç, N., 2008, Two new records of Odonata (Gomphidae) for Turkey, *Gomphus flavipes* (Charpentier, 1825) and *Ophiogomphus cecilia* (Geoffroy in Fourcroy, 1785), with distributional notes on *G. flavipes* and *G. ubadschii* Schmidt, 1953. *Entomological News*, 119: 81-89.

Hagen, H., 1996, Biometrische Untersuchungen an Exuvien von *Anax imperator* Leach und *A. parthenope* Selys vom Südosten Mallorcas (Anisoptera: Aeshnidae). *Advances in Odonatology*, Supplement, 1: 35-42.

Havza, E., Aktaç, N., 1987, Edirne yöresi Odonata faunası üzerine sistematik araştırmalar. *Türkiye I. Entomoloji Kongresi,*13-16 Ekim, İzmir. pp. 743-752.

Heidemann, H., Seidenbusch, R., 2002, *Die Libellenlarven Deutschlands*. Tierwelt Deutschlds, 72, 328 pp.

Hope, P., 2007, *The dragonflies of eastern Muğla province, south-west Turkey*. Land of Lights Publishing, Fethiye, Turkey, 232 pp.

Hope, P., 2008, The Vagrant Emperor *Anax ephippiger* (Burmeister, 1839): proof of breeding in Turkey. *Journal of the British Dragonfly Society*, 24: 32-36.

Kalkman, V.J.,Kop, A.,Wasscher, M., Van Pelt, G.J., 2004a, The dragonflies of the surroundings of Lake Köyceğiz and the River Eşen, Muğla province, SW Turkey (Odonata). *Libellula Supplement*, 5: 39-63.

Kalkman, V.J., Lopau, W., Van Pelt, G.J., 2004b, Hitherto unpublished records of dragonflies from Turkey (Odonata). *Libellula Supplement*, 5: 65-166.

Kempny, P., 1908, Beitrag zur Neuropterenfauna des Orients. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien*, 58: 263-270.

Morton, K. J., 1915, Notes on Odonata from the environs of Constantinople. *Entomologist*, 48: 129-134.

Norling, U., Sahlen, G., 1997, *Odonata, Dragonflies and Damselflies. In:* Nilsson, A. (ed.): Aquatic insects of North Europe: a taxonomic handbook. Vol.2, Apollo Books, Stenstrup, 13-65.

Olias, M., Weihrauch, F., Bedjanič, M., Hacet, N., Marinov, M., Šalamun, A., 2007, *Lestes parvidens* and *L. viridis* in southeastern Europe: a chorological analysis (Odonata: Lestidae). *Libellula*, 26: 243-272.

Schmidt, E., 1985, Habitat inventarization, characterization and bioindication by a “Representative Spectrum of Odonata species (RSO)”. *Odonatologica*, 14: 127-133.

Schneider, W., 1983, The larva of *Gomphus davidi* Selys, 1887. *Hydrobiologia*, 98: 245-248.

Schneider, W., 1985, Dragonfly records from SE-Turkey (Insecta: Odonata). *Senckenbergiana biologica*, 66: 67-78.

Seidenbusch, R., 1995a, Description of the last instar larva of *Sonjagaster insignis* Schneider 1845 (Odonata: Cordulegastridae). *Sulzbach-Rosenberger Libellenrundbriefe* I: 3 pp.

Seidenbusch, R., 1995b, Description of the last instar larvae of *Orthetrum taeniolatum* Schneider 1845 and *Orthetrum sabina* Drury 1770 (Anisoptera: Libellulidae). *Sulzbach-Rosenberger Libellenrundbriefe*, I: 3 pp.

Seidenbusch, R., 1995c, Diskrimination der Exuviae bei *Onychogomphus forcipatus forcipatus* Linnaeus 1758 und seinen subspecies *O. f. unguiculatus* Vanderlinden 1823 und *O. f. albotibialis* Schmidt 1954. *Sulzbach-Rosenberger Libellenrundbriefe,* I: 2 pp.

Seidenbusch, R., 1995d, Description of the last instar larva of *Diplacodes lefebvrei* Rambur 1842 (Anisoptera: Libellulidae). *Sulzbach-Rosenberger Libellenrundbriefe,* I: 2 pp.

Seidenbusch, R., 1995e, Comparison of the last instar larvae of *Gomphus vulgatissimus* Linnaeus 1758, *Gomphus schneideri* Selys 1850, *Gomphus epophthalmus* Selys 1872 (Anisoptera: Gomphidae). *Sulzbach-Rosenberger Libellenrundbriefe*, II: 4 pp.

Seidenbusch, R., 1995f, Comparison of the last instar larvae of *Onychogomphus flexuosus* Schneider 1845, *Onychogomphus forcipatus albotibialis* Schmidt 1954 (Anisoptera: Gomphidae). *Sulzbach-Rosenberger Libellenrundbriefe*, II: 2 pp.

Seidenbusch, R., 1996a, Notes on the identification of the exuviae of *Coenagrion pulchellum* (Vander Linden) and *C. puella* (Linnaeus). *Journal of the British Dragonfly Society*, 12: 22-25.

Seidenbusch, R., 1996b, Description of the last instar larva of *Somatochlora meridionalis* Nielsen, 1935 (Anisoptera: Corduliidae). *Odonatologica*, 25: 303-306.

Seidenbusch, R., 1997, Larval comparison: *Erythromma viridulum* Charpentier 1840, *Erythromma lindeni* Selys 1848. *Sulzbach-Rosenberger Libellenrundbriefe*, IV: 4 pp.

Seidenbusch, R., 1999, Description of three last instar larvae of the south Turkish area; *Brachythemis fuscopalliata* Selys, 1887 (Anisoptera: Libellulidae), *Sympetrum haritonovi* Borisov, 1983 (Anisoptera: Libellulidae), *Onychogomphus assimilis* Schneider, 1845 (Anisoptera: Gomphidae). *Sulzbach-Rosenberger Libellenrundbriefe*, X: 11 pp.

Seidenbusch, R., Heidemann, H., 2007, Ein neues Merkmal zur Identifikation der Larven von *Diplacodes lefebvrii* unter den paläarktischen Libellulidae (Odonata). *Libellula*, 26: 107-112.

Spagnolini, A., 1877, Di alcune libellule raccolte nei dintorni di Constantinopoli. *Bullettino della Società Entomologica Italiana*, 9: 302–310.

Suhling, F., Müller, O., 1996, *Die Flussjungfern Europas (Gomphidae)*. Westarp, Magdeburg. [Neue Brehm-Bücherei 628], 237 pp.

Theischinger, G., Fleck, G., 2003, A new character useful for taxonomy and phylogeny of Anisoptera (Odonata). *Bulletin de la Société entomologique de France*, 108: 409-412.

Van Pelt, G.J., 2004, New records of dragonflies from Turkey (Odonata). *Libellula Supplement*, 5: 3-38.

Verschuren, D., Demirsoy, A., Dumont, H.J., 1987, Description of the larva of *Cordulegaster mzymtae* Bartenef, 1929, with a discussion of its taxonomic position (Anisoptera: Cordulegastridae). *Odonatologica*, 16: 401-406.

Verschuren, D., 1989, Revision of the larvae of West-Palaearctic *Cordulegaster* Leach, 1815 (Odonata, Cordulegastridae), with a key to the considered taxa and a discussion on their affinity. *Bulletin et Annales de la Société royale entomologique de Belgigue*, 125: 5-35.

Yazıcıoğlu,T., 1982, Dragonflies from the Ergene river basin, Thrace, Turkey. *Notulae odonatologicae*, 1: 148-150.

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