



Contribution to the *Calopteryx*-forms of the Peloponnesus (Odonata: Calopterygidae)

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Abstract

Forty-four specimens of the *Calopteryx splendens/ balcanica* complex of the Peloponnesus and adjacent areas have been found and were analyzed by different methods. The aim of this study is to characterize a *Calopteryx* form with broad wings found 1979 in the Peloponnesus. The length and width of the fore wings of all found specimens were measured. A resulting quotient was used in our analysis. This analysis recovered two principal groups of *Calopteryx*, one mainly from the Southern Peloponnesus and one with specimens of *Calopteryx balcanica* from other locations in Greece and other *Calopteryx* species from other countries North, West and East of Greece. Some other structures of the wings have also been analyzed. *Calopteryx* specimens from Southern Peloponnesus have broad fore wings; and in some areas of the wings typical structures may be observed. The status of the *Calopteryx* form from the Southern Peloponnesus is discussed. The results lead to the conclusion, that the specimens from the South of the Peloponnesus may be an atavistic population of *C. balcanica* resulting from glacial periods. The Northern forms of *C. balcanica* may be influenced by other forms of *Calopteryx*. The Northern form was named *C. balcanica* by Fudakowski (1930) from Bosnia and Herzegowina. The status of this *Calopteryx* form of the Southern Peloponnesus should be further investigated.

Keywords: *Calopteryx splendens/ balcanica*, Southern Peloponnesus, Greece, River Eurotas, cluster analysis, wing size

Introduction

There are only few publications on the damselfly fauna within the Peloponnesus. The few recent reports contribute mainly to the North of Greece. Stobbe (1990) has measured the length of the wings of *Calopteryx splendens* (Harris 1782). He has compared two locations within Greece. In his Northern group the wings were shorter, but he has named all investigated specimens as *C. splendens-balcanica*-complex. Lopau (2010) has described the findings of *Calopteryx splendens* in the Peloponnesus, but he has not mentioned a special form from the Southern Peloponnesus. Fudakowsky (1930) has described *Calopteryx splendens balcanica* from Trebinje, Mostar (Bosnia and Herzegovina, North of Greece). Dijkstra (2006) has described *Calopteryx balcanica* Fudakowsky 1930 from Greek islands and Peloponnesus, along the Dalmatian coast to Croatia, but he has not mentioned a typical form for Greece. He has defined the area of occurrence in Greece and in the Peloponnesus only regarding the wing colours.

Galletti & Pavesi (1983) have described findings of Odonata from the Balkan and the North of Greece. They have found *Calopteryx splendens* and *Epallage fatime* in Greece. They have measured the length and width of the hind wings (ala posterior) and have described a quotient from these measurements. Sadeghi et al. (2010) have investigated *C. splendens* specimens from Europe, but not from Greece. They have used genetic results for a cluster analysis using genetic markers. They could find genetic differences and have concluded that species specific results can help to categorize the species of the *C. splendens*-complex. Sadeghi et al. (2009) have investigated the wing shape using 19 landmarks on the wings. They used specimens from many countries in Europe and Asia including from Greece, Thesprotia (Northern Greece). They could find more broad wings in Albanian and Greek specimens. Sadeghi & Dumont (2014) analysed the *Calopteryx splendens* complex from whole Europe and Western Asia. They have used a method to measure the wing area also with 19 landmarks. They have described the specimens from the Balkan and Greece with the most large and broad wings in contrast to the Northern locations. Sadeghi & Dumont (2014) investigated 580 specimens with a mean of 29 specimens of each location, but they did not include specimens from the Peloponnesus. Schmidt (1954) has analysed the *Calopteryx* species from Europe and Asia. In

principal he has found a range from large wings in the East to small wings in the West. He has mentioned *C. balcanica* Fudakowski from Kalavrita, N.-Peloponnesus. He has not discussed a broad fore wing. He has found clear horns at the back of the head (“Occipitalhoecker”) in *C. xanthostoma* und *C. balcanica*.

Schroeter A. et al. (2015) have described specimens of *C. splendens tschaldirica* Bartenev 1909 and *C. splendens intermedia* Selys 1890 from the Caucasus area. They used 11 specimens of *C. splendens tschaldirica* and 29 specimens of *C. splendens intermedia*. Adamovic & Vijatov (1996) investigated *C. balcanica* (59 specimens) and *C. ancilla* Selys 1853 (42 specimens) from the Balkan area. They measured wing length and width to create a quotient.

My investigations of the Peloponnesus were made from 1979 to 1991. In 1979 I have found a specimen at the River Eurotas in the Peloponnesus with broad wings, which I could not determine with recent publications. In 1986, 1990 and 1991 I tried to find more specimens of this type. With the additional specimens I could perform some investigations. Within the Peloponnesus the special *Calopteryx*-form was found in many locations. This form has broad wings and might be confused with *Calopteryx virgo* Linneus, 1758. Within these populations I could find only females with pseudopterostigma, similar to females the *Calopteryx splendens*-type. There are no reports on a form with broad wings in recent papers, but ‘*C. virgo*’ was mentioned from Lopau in the South of Peloponnese (2010).

Material and Methods

The locations

Location	Latitude	Longitude
Greece, P. Louros	39,3878	20,8721
Greece, P. Thiamis	39,5866	20,1422
Greece, P. Pinios	37,8733	21,2726
Greece, Olympia	37,6288	21,6533
Greece, P. Alphios	37,3645	22,1411
Greece, Thuria	37,1250	22,2816
Greece, Sparta	37,0744	22,4302
Greece, P. Tzane	37,0444	22,1140
Greece, Skala	36,8511	22,6663
Germany, Bavaria, Kallmünz	49,1602	11,9597

Czechia, Boehmen, Paradubice	50.0300	15.7700
Austria, Keutschach	46,5943	14,1863
Italy, Modigliani near Forli	44.2170	12.0500
Turkey, Samsun	41.2830	36.3170

The used specimens of *Calopteryx* ssp. are mainly from the Peloponnesus and from Northern Greece and some for comparison from Austria, Southeast Germany, Czechia, Italy, and Turkey (cf. locations, Tab. 1 and Fig. 2).

Tab. 1: The Values: *Calopteryx* ssp. of Greece and some other regions

Quotient	Arc-Cells	PN-2-Cells	PN-3-Cells	<i>Calopteryx splendens</i> ssp. in Greece and other regions	
2,62	3,25	7,50	0,50	90/69m-P.Alphios	Group 1
2,62	2,25	19,50	1,50	91/15m-P.Tzane	
2,67	3,25	8,00	1,50	90/82m-Sparta	
2,67	2,00	6,50	0,00	79/1m-Sparta	
2,68	2,75	7,00	0,00	90/81m-Sparta	
2,71	2,00	5,00	0,50	90/85m-Thuria	
2,72	3,00	4,00	0,00	86/3m-Sparta	
2,74	2,00	28,00	4,00	91/11m-Olympia	
2,76	1,75	3,50	0,00	90/68m-P.Alphios	
2,76	1,50	16,50	1,50	90/67m-P.Pinios	
2,78	3,75	7,50	0,00	90/57m-P.Thiamis	
2,79	2,00	2,50	0,00	90/79m-Skala	
2,80	3,75	14,50	1,50	86/1m-Sparta	
2,83	5,00	20,50	3,00	86/2m-Sparta	
2,83	1,75	14,00	0,00	90/66m-P.Pinios	
2,89	3,25	12,50	0,50	91/16m-P.Tzane	
2,95	1,75	5,50	0,50	90/58m-P.Louros	Group 2
2,97	1,25	7,00	0,00	90/55m-P.Thiamis	
2,99	1,00	7,50	0,50	90/59m-P.Louros	
2,99	2,00	4,50	0,00	79/99m-P.Pinios	
3,01	1,75	0,00	0,00	933/2000m-CZ	
3,04	2,00	1,00	0,00	27/1987m-It,C.s.caprai	
3,05	1,75	3,50	0,00	3/1985m-C.intermedia,Turkey	
3,10	1,75	0,00	0,00	930/2000m-CZ	
3,11	1,50	0,00	0,00	23/1990m-BY, Kallmuenz	

3,13	1,25	0,50	0,00	934/2000m-CZ	
3,14	2,75	2,00	0,00	91/12m-Olympia	
3,16	2,25	8,00	0,00	323/1994m-Turkey	
3,16	1,25	4,50	0,00	224/1994m-BY, Kallmuenz	
3,18	1,00	2,50	0,00	38/1995m-BY, Kallm.	
3,22	0,75	1,00	0,00	204/1990m-BY, Kallmuenz	
3,25	1,00	2,00	0,00	15.74m-A,Keutschach	
3,28	1,50	0,50	0,00	205/1990m-BY, Kallmuenz	
3,08	1,75	1,00	0,00	652.2000-TY	
3,16	1,25	2,50	0,00	653.2000-TY	

Fig. 2: Map with locations of the specimens of the Peloponnesus (red: group 1, yellow: group 2)
(Thanks to Lencer: http://www.esys.org/rev_info/Griechenland/Peloponnes.html)



Methods

35 males (21 from Greece) and 9 females of *Calopteryx* ssp. from the Southern Peloponnesus and from other locations for comparison have been found within 12 years, in 1979, 1986, 1990, and in 1991. During the observation I have tried to protect the locations as most as possible. Therefore, the number of specimens collected was limited. Fresh water is rare in the Southern Peloponnesus and is remaining mostly only in the mountains, with small streams during the whole year, mostly dried in the lower parts. In some locations I had to walk up the dry stream bed to come to an area with water and plants in the mountains where *Calopteryx* was flying. These waters were mostly stagnant. At such locations few specimens could be found. Only the River Inous near Sparta has had a larger population. This stream was 5m wide with small bushes on the shore, where the *Calopteryx* was perching, mostly in the shadow at noon. At each bush ca. 150 specimens were sitting along the river. At noon and in May while it was subtropical hot, only few specimens were flying over the water. This type of flying I have seen at other locations, also. The river Alfios in a nice valley near Megapolis was grown with shore plants nearly all over. Here, I could find *Calopteryx* together with *Epallage fatime* (Charpentier, 1840).

Many details of the body were investigated, also the posterior part of the head. Within the wing veins the number of the Arc-Cells (cf. Fig. 6), the PN-2-Row-Cells and the PN-3-Row-Cells (cf. Fig. 5) were counted. The dorsal appendices were also investigated. From the 9 females the apical cells beyond the Pseudopterostigma were counted at both sides, including some double cells (cf. Fig. 12). The middle of the countings each has been used. The naming of the anatomy followed Geijskes & van Tol (1983).

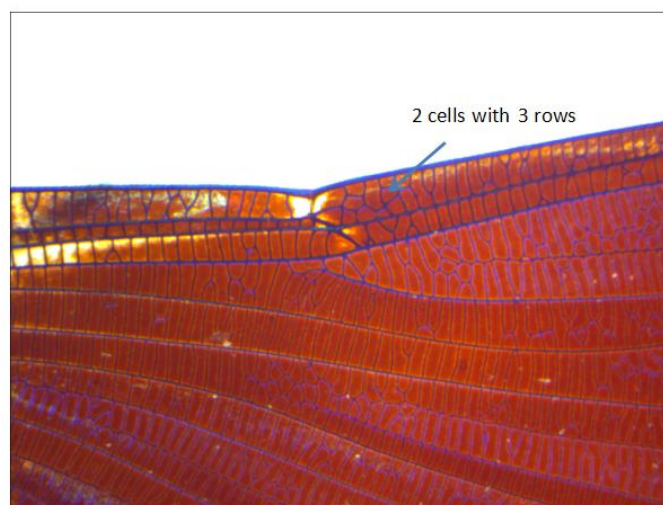


Fig. 5: No. 15.1991, example for post-nodal-cells (PN, PN-2/3-Row-Cells) with 2 or 3 rows (group 1)

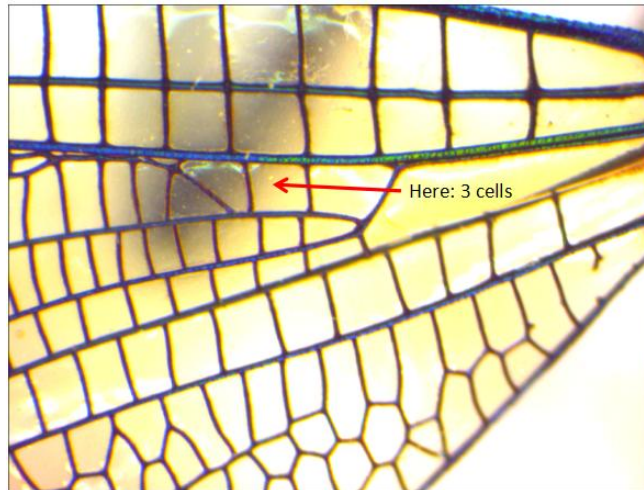


Fig. 6: No. 15.1991, example for ARC-Cells, here: 3 cells (group 1)

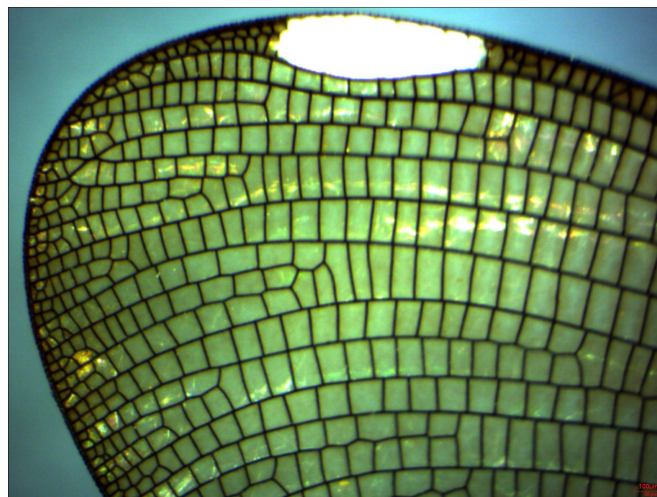
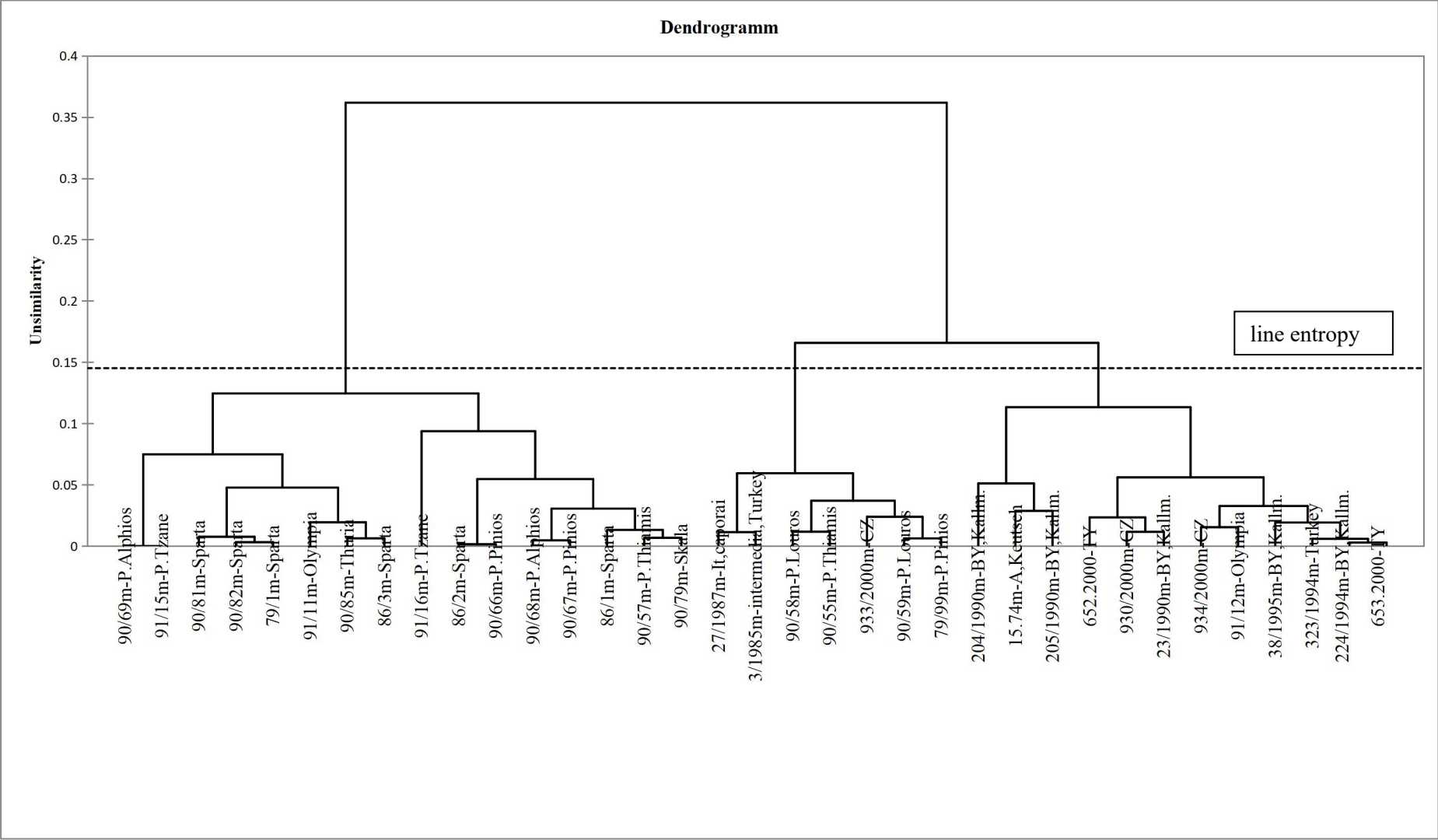


Fig. 12: No. 83/1990, *Calopteryx* form of Southern Peloponnesus, female near Skala, group 1

The males fore wings have been measured. The fore wings of both sides were measured by a calliper (basis to apex) and the maximal width (in a rectangular angle to the Post-Costa). A quotient of the mean of length and width of each specimen was calculated.

The quotient of the males of the *Calopteryx* ssp. from the Peloponnesus and from other localities (cf. locations, Tab. 1 und Fig. 1) could be used for further calculations. The calculated quotients were used for the cluster-analysis. The principal analysis was calculated according to Steinhausen and Langer (1977). I used Xlstat (in Excel), the methods in detail: “line clustering”, no reduction, ”Euclidian distance“, “un-similarity“, Agglomeration method: “unweighted pair-group average“ and “line entropy“ (height of the distance line in the cluster analysis). The chosen data (cf. Table 1, left column “quotient”) were marked and the cluster-analysis was started with Xlstat “agglomerative hierarchic clustering (AHC)” within MS Excel. The resulting figure is included as Fig. 1.

Fig.1: Cluster-Analysis-Dendrogram of the relationship of the length and the width of the fore wings as quotient of males of *Calopteryx* ssp. of Greece and some other regions, left Cluster/group 1, right Cluster/group 2



Results

In the following part, the specimens from the South of the Peloponnesus are described in detail.

Male: The body (Fig. 10) of the male is blue metallic. The abdomen segments 6-9 are mainly green metallic. At the thorax the sutures between eps.3 and epm.3 in the ventral part are yellow. Between ips.2 and cx.2 is also a yellow suture. And, between cx.1 and tr.1 is a yellow suture. Two small transverse lines around the middle between epm.1 and cx.1 are yellow. The three ocelli at the head vertex and two small spots right and left of the caudal ocellus are yellow. At both sides of the eyes at the frons is a yellow spot. The labium shows a yellow middle line. The joints of legs and of the mouth parts are yellowish. The males (Fig. 9) have a small horn at the caudal border of the head. At the dorsal appendices the males have a small edge at the medial cranial part of the crista (Fig. 7). The males have a white colour at the ventral side of the last two segments (Fig. 10). At dried specimens the colour changed to dark yellow. This colour can be seen from the 8th to the 10th segment. In the middle the black line is fading from the segment 8 to end of the 9th segment. Segment 9 and 10 are mostly dark yellow. There are some small hairs in the middle of the ventral side of the last two segments. The wings: The dark wing colour is starting between wing base and nodus with an irregular border and reaches to the wing apex. The males do not have a pseudoptero stigma or pterostigma. Due to the broad wings the hyaline wing part at the basis is very small. Specimens of the Southern Peloponnesus have a small angle at the nodus seen from above (Fig. 3). Most specimens have more than 2 Arc-Cells (Fig. 6). The PN-2-Row-Cells are mostly 5 or more and the PN-3-Row-Cells (Fig. 5) are mostly only in one cell (cf. Tab. 1).



Fig. 3: Group 1: No. 15.1991, length/width: 2.62-2.89



Fig. 7: No. 15/1991, app. ventral of the male from the group 1

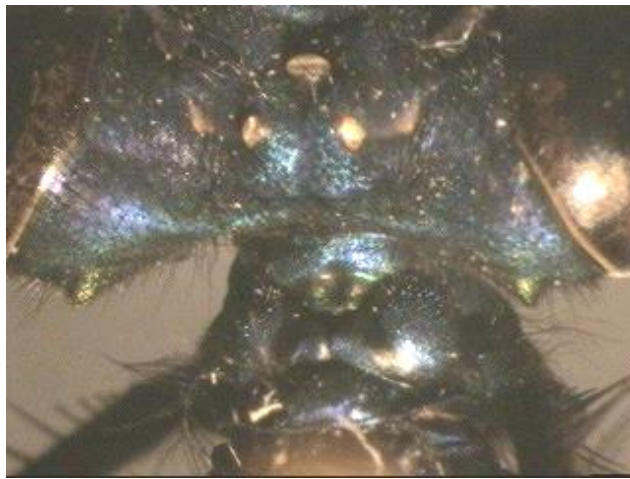


Fig. 9: No. 15/1991, head horn at male from the group 1



Fig. 10: *Calopteryx* form of Southern Peloponnes, pair near Sparta

The females are light greenish metallic. The suture between eps.3 and epm.3 is yellow in the lower third. Also, the lower border of epm.3 is yellow. A yellow line at the thorax reaches from the frontal border of the epm.3 to the ips.2. The basis between ips.3 and cx.3 is yellow as the spot at the caudal border, at the cx.2, and at the cx.1. The ventral side of the third thorax segment is black with a yellow border. The upper side of the head is similar to the males. The labrum is yellow and marked with black spots at the borders and also at the sutures. The labium is similar to the male's labium yellow at the middle suture, but has more yellow at the borders. The ventral lateral borders of the abdominal segments are yellow. At the upper side of the abdomen is a yellow line from the 9. segment to the 10. segment. The yellow line is thin at the dorsal side of the 8. segment and unclear (Fig. 13). The wings of the females are all-over greenish to smoky brownish. The pseudopterostigma is white and in the middle broad, 9-10 cells long. The apical cells beyond the pseudopterostigma in 7 females of the Southern Peloponnesus have 8 to 14 cells and 1-4 cells may be double (Fig. 12).

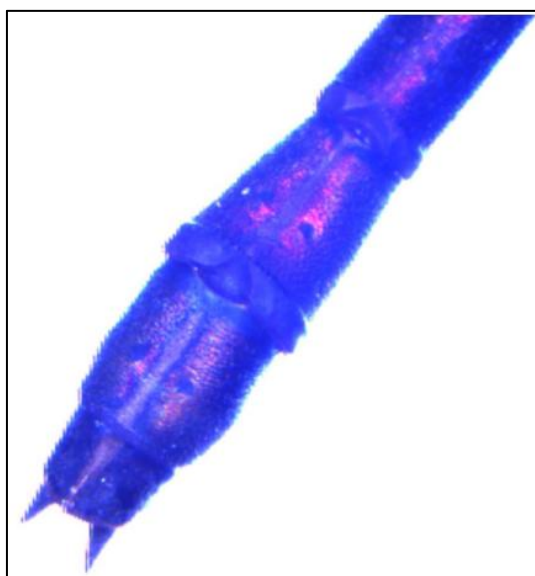


Fig. 13: No. 83/1990, *Calopteryx* form of Southern Peloponnesus, female near Skala, group 1: Last segments, yellow line only on S 9 and S 10

The cluster-analysis could divide the investigated specimens in two groups. **Group 1** (cluster 1) contains the specimens with broad wings and quotients less than 2.9 (Fig. 3) and includes specimens from the Southern Peloponnesus (Fig. 1). **Group 2** (cluster 2) represents specimens from Northern Greek and other regions with quotients above 2.9 (Fig. 4).



Fig. 4: Group 2: No. 55.1990, length/width: 2.95-3.16

The form in the Southern Peloponnesus is representing a **group 1** (quotient <2.9) with a mean of the wing quotient of 2.74 ± 0.0763 .

The Northern **group 2** represents the hitherto known *Calopteryx balcanica* from Northern Greece and other variants of *C. splendens* or species from countries out of Greece for comparison. The members of **group 2** have a mean of the wing quotient of 3.01 ± 0.076 . The members of **group 2** from outside of Greece (Turkei, Austria, Italy, Germany) have a mean of the wing ratio of 3.14 ± 0.0797 . The both species *C. s. caprai* from Italy and *C. intermedia* from Turkey are sitting in a separate sub-group in cluster 2 (Fig. 1) together with some specimens from Northern Greece and from Czechia, the other sub-groups contains all the specimens from Northern Greek, Germany, Czechia and Austria.

A comparison of the specimens of both groups shows also some other differences. The males of **group 1** (Fig. 9) have a horn at the caudal border of the head. At the dorsal appendices the males have an edge at the cranial end of the medial crista in **group 1** (Fig. 7), which is not clear in **group 2** (Fig. 8).



Fig. 8: No. 55/1990, app. ventral of the male from the group 2

The specimens of **group 1** have a clear angle at the nodus of the fore wings and general more cells (Fig. 3). The most specimens have more than 2 Arc-Cells (Fig. 6, Tab. 1). The PN-2-Row-Cells (Fig. 5) in group 1 have a number of 5-20 in contrast to group 2 with numbers from 1-8 (Tab. 1). The PN-3-Row-Cells are visible in **group 1** in 0-3 cell rows but are only seldom visible in **group 2**.

A female of **group 1** from near to Sparta within the Peloponnesus is figured in Fig. 11 in contrast to a female of **group 2** from Louros near Prevesa in Epirus. At the abdomen of the females of group 1 the yellow dorsal line is thin and unclear at the 8. segment. This is a contrast to the *C. balcanica*-females of the **group 2**, which have a clear yellow line from the 8. to the 10. segment. The apical cells behind the pseudopterostigma of 7 females of **group 1** have 8-14 cells and 1-4 double cells (Fig. 12). The two *C. balcanica*-females of **group 2** have 15-17 cells behind the pseudopterostigma and 3-8 double cells.

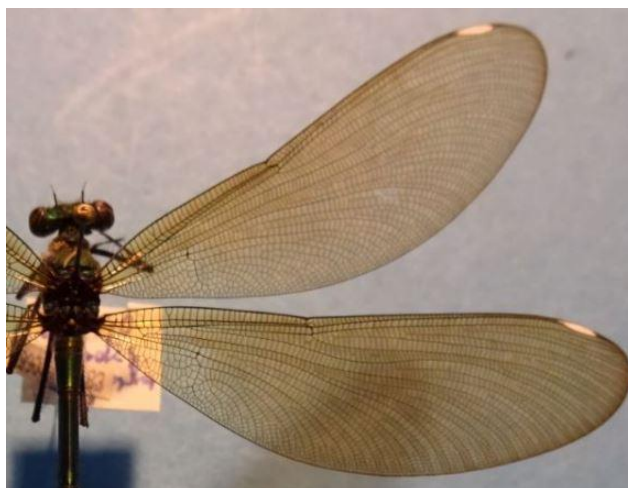


Fig. 11: No. 83/1990, *Calopteryx* form of Southern Peloponnesus, female near Sparta, group 1

Discussion

Stobbe (1990) has compared the specimens of *Calopteryx splendens* from different parts of Greece. He found shorter wings in the Northern group. But, did not mention *Calopteryx* spp. with broad wings. Lopau (2010) has described some localities within the Peloponnesus for *Calopteryx splendens*, but he has not mentioned a special form from the Southern Peloponnesus. And, he has observed a '*C. virgo*' in the Peloponnesus. Fudakowsky (1930) has described *Calopteryx splendens balcanica* from Trebinje, Mostar (Bosnia and Herzegovina), but he could not describe specimens from Greece. He has not mentioned broad fore wings. Bosnia and Herzegovina are near to the Northern range of *Calopteryx balcanica*.

The typical form in Northern and Western Greece is *C. balcanica* (Dumont 2006). Dumont (2006) has only discussed the wing colours, not any other facts; his Fig. at page 67 of *C. balcanica* has a hyaline apex, which is not typical for *C. balcanica*. Adomovic & Vijatov (1996) have investigated *C. balcanica* (59 specimens) and *C. ancilla* (42 specimens) from the Balkan and have found quotients of fore wing length and width from 2.97 to 3.20, which is comparable to my **group 2**. They have used numbers of specimens, which are comparable to my numbers (cf. methods). They could differentiate the both species *C. balcanica* and *C. ancilla* using the quotients. But they have not used specimens from the Peloponnesus.

Galletti & Pavesi (1983) have measured only the hindwings from specimens from Macedonia, Bulgaria and the North of Greece. They have described the quotient in a range of 2,9-3,3 for the males; respecting that the fore and hind wings are more or less similar in the North of Greece and the Southern Balkan, the range seems to be similar with my **group 2**. Schroeter et al. (2015) described phenological investigations of *C. splendens tschaldirica* and *C. splendens intermedia* and could differentiate the both species from the Caucasus region. They have used 11 specimens of *C. splendens tschaldirica* and 29 specimens of *C. splendens intermedia*. The number of specimens is comparable to the number of specimens, which I have used (cf. methods).

Schmidt (1954) has analysed the *Calopteryx* species from Europe and Asia. He has mentioned *C. balcanica* Fudakowski from Kalavrita in the Northern Peloponnesus. He has not mentioned a broad fore wing, but he has made a comparison of the length of wings. He has described smaller horns at the back of the head (“Occipitalhoecker”) in *C. xanthostoma* und *balcanica* in contrast to Western species within Europe. The horns at the back of the head in the **group 1** of my investigations may be as in the Fig 1c of Schmidt (1954).

Sadeghi et al., 2010 have investigated *C. splendens* specimens from Europe, but not from Greece, using a cluster analysis with genetic markers. They have concluded that species specific results can help to categorize the species of the *C. splendens*-complex. From their results they have discussed the possibility for “atavistic (probably pre-Pleistocene) gene pools” of *C. waterstoni*, *C. ancilla*, *C. orientalis*, and *C. xanthostoma*. He has not mentioned *Calopteryx balcanica*.

Sadeghi et al. (2009) have investigated the wing shape using landmarks on the wings. They used specimens from countries in Europe and Asia including from Northern Greece, Thesprotia. They could find more broad wings in Albanian and Greek specimens. But they have not investigated specimens from Peloponnesus.

Sadeghi & Dumont (2014) have analysed the *Calopteryx splendens*-complex from whole Europe and neighbouring parts of Western Asia. They have investigated 38 specimens out of Northern Greece from Saulopoulo, Ioannina and Eleftheri, Thesprotia, which is comparable to the number of my specimens (cf. methods). The method of Sadeghi & Dumont (2014) could show that specimens of the *Calopteryx-splendens*-complex with large wing areas are mostly found in the Southern Balkan and the wing areas are smaller in the North (fig. 15). From these analyses using the wing areas has resulted a clear group for *Calopteryx* ‚*balcanica*‘. They have analysed only one wing of each specimen and has not used specimens of the Peloponnesus.

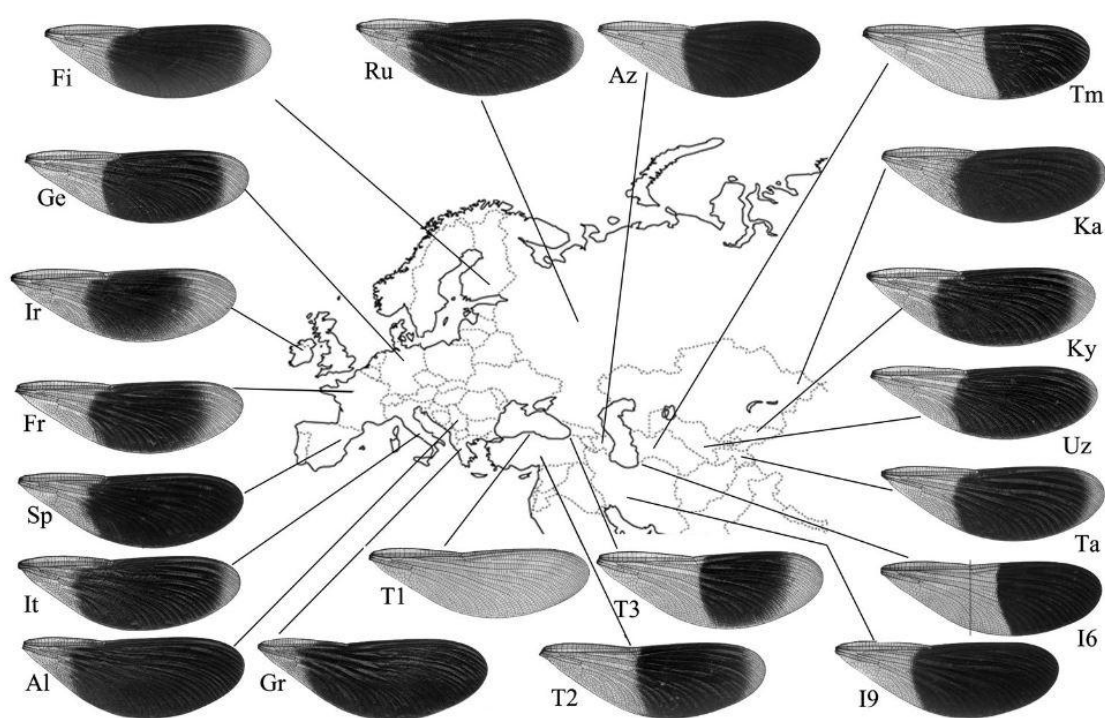


Fig. 1. Map of localities sampled and a thumbnail picture of a wing of an individual for each population.

Fig. 15: *Calopteryx splendens*-forms according to analyses from Sadeghi & Dumont (2014)

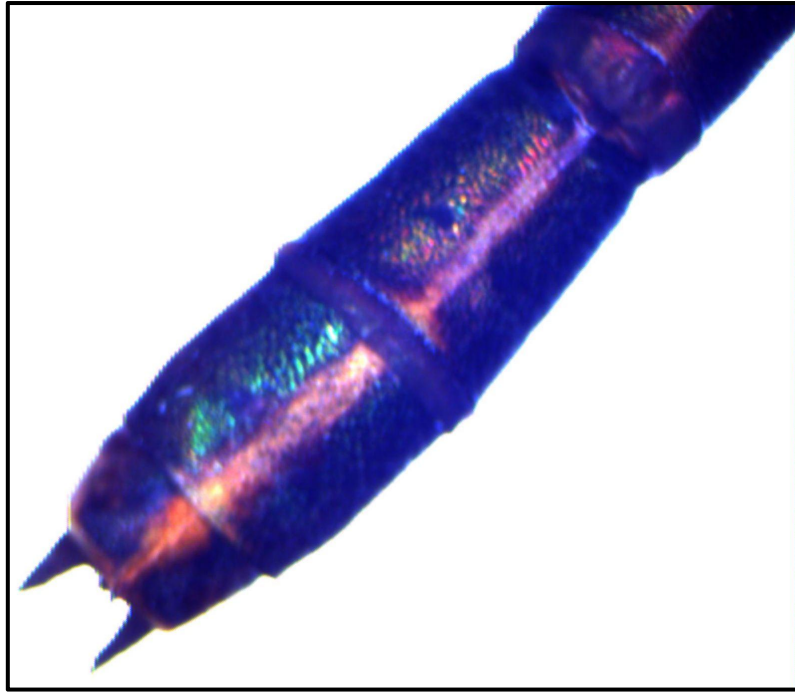
My own investigations using the cluster analysis can lead to the conclusion, that the form in the Southern Peloponnesus is representing a separate group in **group 1** (quotient <2.9) with the lowest mean of the wing ratio of $2,74 \pm 0,0763$. The smaller the quotient is, the width is larger in comparison to the length.

The Northern **group 2** represents the hitherto known *Calopteryx balcanica* from Northern Greece and of other the *C. splendens*-variants from countries outside of Greece. The members of **group 2** from Northern Greece have a higher mean of the wing ratio of $3,01 \pm 0,076$,

showing smaller wings. The members of **group 2** from outside of Greece (Turkey, Austria, Italy, Germany) have a higher mean of the wing quotients with $3,14 \pm 0,0797$, showing the smallest wings. The lowest mean in the **group 1** shows that this group is well isolated from the other populations of *Calopteryx balcanica* in Greece. Between the **group 1** and the **group 2** there is no overlapping of the standard deviations. The specimens from outside of the Peloponnese and from outside of Greece show higher wing quotients as in the South of the Peloponnese.

In **group 2**, the Northern specimens are included. *C. balcanica* from Greece, *C. s. caprai* from Italy and *C. intermedia* from Turkey are sitting in separate sub-clusters together with some specimens from Northern Greece and from Czechia, other sub-clusters contain specimens from Northern Greece, Germany, Czechia and Austria. All sub-clusters in **group 2** are combined at a high level. Therefore, and regarding the means of the quotients, the specimens from Northern Greece have more similar wings to the *Calopteryx* forms of the other countries in Europe as to the form of the Peloponnesus.

Group 1 shows remarkable differences to **group 2** (*C. balcanica*). The wings of **group 1** are broad. The observer may think, that this may be a form of *C. virgo* (*C. virgo festiva* [Brulle 1832] is known from Northern Greece). The specimens of **group 1** have a visible angle at the nodus seen from above. The specimens have more cells in their broad wings, more Arc-Cells (Fig. 6) and PN-2-Row-Cells or PN-3-Row-Cells (Fig. 5). The males have a clear visible horn at the caudal border of the head (Fig 9, which is smaller as in *C. virgo* (cf. Dumont, 2006). The horns are also described by Schmidt (1954). The males have an additional edge at the cranial part of the medial crista at the dorsal appendices (Fig. 7). The colour of the ventral part of the last segments of the living males is bright white. The *Calopteryx*-population was observed in the summer months and in more high regions of the Southern Peloponnesus. At the females of the form of the Southern Peloponnesus the position of the pseudopterostigma of the fore wings is more similar to *Calopteryx splendens*-type, bright white and is sitting more apical (cf. Fig. 11, 12). The yellow line on the S 8-10 is clear on females of **group 2** (Fig. 14) and mostly weak on S9 and S10 on females of **group 1** (Fig. 13).



**Fig. 14: No. 61/1990, *Calopteryx balcanica*, female from Louros, Greece
group 2: Last segments, yellow line on S 8 to S 10**

This form of the Southern Peloponnesus is separated from the Northern *C. balcanica*-forms due to the form of the broad wings and some other details of the wings, the head and the appendices. The first specimen was found near Sparta at the river Eurotas. The Southern form of the **group 1** is isolated from **group 2** mainly by the mountains of the Peloponnesus and the occurrence at rivers, which are dry in summer in the lower parts. This may be a sign for a very old population, which has survived the last glacial period. *C. balcanica* may be found in the North West of the Peloponnesus together with some individuals of the Southern form with broad wings. Due to the bridge over the Golf of Corinth the spreading of Southern form to the West Coast of Northern Greece may be going on in future.

Conclusion

The analysis according to Sadeghi & Dumont (2014) has separated the Southern population of the Balkan from the Northern populations (cf. Fig. 13). My investigations have also separated the form outside of the Southern Peloponnesus from the Northern Greece and other regions. These population of the Southern Peloponnesus can be seen as good separated from the Northern specimens. The first male of this form was seen at the River Eurotas near Sparta in 1979. Due to the growing drinking water use from the mountains, the biotopes of the Southern population are endangered.

The results and the information from the mentioned papers may lead to the conclusion, that the specimens from the **group 1** from the South of the Peloponnesus may be an atavistic population of *C. balcanica* s. str. or another old form resulting from glacial periods. The less broad forms of *C. balcanica* are found in the North of Greece and they may have been influenced by other forms and they came from other regions after glacial periods. The Northern form of the Southern Balkan was named *C. balcanica* from Fudakowski (1930). Further investigations should clear the status of the form of the Peloponnesus.

References

- [1] Adomovic Z.R. & S.T. Vijatov (1996): Morphometric examination of *Calopteryx balcanica* Fudakowski, 1930 and *C. splendens ancilla* Selys, 1853 (Zygoptera: Calopterygidae). *Odonatologica* 25: 109-118
- [2] Dumont H. J. (2006): *Calopteryx* Leach, 1814. Demoiselles. In: Dijkstra K.-D.B. & R. Lewington (Eds), *Field guide to the dragonflies of Britain and Europe*: 66-67. British Wildlife Publishing, Gillingham: 320 S.
- [3] Fudakowsky J. (1930): Über die Formen von *Calopteryx splendens* Harr. aus Dalmatien and Herzegowina (Odonata). *Annales Musei Zoologici Polonici* IX (6): 57-63, pl. X
- [4] Galletti, P. A. & M. Pavesi (1983): Su alcuni Odonati di Grecia. *G. it. Ent.* 1: 247-260
- [5] Geijskes, D. C. & J. van Tol (1983): *De libellen van Nederland*. Koninklijke Nederlandse Natuurhistorische Vereniging. Hoogwoud (N.H.): 368 S.
- [6] Lohmann H. (1992): SIO/IUCN-Expedition nach Süditalien und Griechenland 17.6-6.7.1992. Unveröffentlichtes Manuskript, Rheinfelden
- [7] Lopau W. (2010): *Verbreitungsatlas der Libellen in Griechenland (Odonata)*. *Libellula Supplement* 10: 5-153.
- [8] Sadeghi S., T. Kyndt & H. J. Dumont (2010): Genetic diversity, population structure and taxonomy of *Calopteryx splendens* (Odonata: Calopterygidae): An AFLP analysis. *Eur. J. Entomol.* 107: 137–146
- [9] Sadeghi S., D. Adriaens & H. J. Dumont (2009): Geometric morphometric analysis of wing shape variation in ten European populations of *Calopteryx splendens* (Harris, 1782) (Zygoptera: Calopterygidae). *Odonatologica* 38(4): 341-357
- [10] Sadeghi S. & H. J. Dumont (2014): Variation in the shape of the wings and taxonomy of Eurasian populations of the *Calopteryx splendens* complex (Odonata: Calopterygidae). *Odonatologica* 111: 575–583.

- [11] Schmidt Erich (1954): Ergebnisse der Österreichischen Iran-Expedition 1949/50. Die Libellen Irans. Erforschungsgeschichte unter Berücksichtigung der noch nicht publizierten Sammlungen von Aellen, Biggs, Esfandiari, Schäuffele und Scharif, nebst Fundortliste, kritischem Artenverzeichnis und vorläufiger Analyse. Sitzungsberichte d. mathem.-naturw. Kl.. Abt. I, 163. B d, 4. und 5. Heft.
- [12] Schroeter A., M. Seehausen, B. Kunz, A. Günther, T. Schneider & R. Joedicke (2015): Update of the Odonata fauna of Georgia, southern Caucasus ecoregion. Odonatologica 44: 279-342
- [13] Steinhausen and Langer (1977): Clusteranalyse. Einführung in Methoden und Verfahren der automatischen Klassifikation. Walter de Gruyter, Berlin, New York, 206p.
- [14] Stobbe H. (1990): Bemerkungen zur Gattung Calopteryx in Griechenland. Naturkundlicher Rundbrief 4: 5-19.