

SHORT COMMUNICATIONS

**HYBRIDISATION IN *CALOPTERYX ORIENTALIS* (SÉLYS)
EAST OF THE SHORES OF THE SOUTH CASPIAN LAKE
(ZYGOPTERA: CALOPTERYGIDAE)**

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C. orientalis occupies a narrow fringe along the southern rim of the Caspian lake. East of the Caspian, it hybridises with *C. samarcandica* Bartenev, 1912. The hybrid zone takes the form of a progressive cline, and extends from the Kopet Dag, across the Tedzhen-Harirud to the Murgab catchments. The Karakumskyi canal is suspected to speed up hybridisation considerably.

INTRODUCTION

As usual in the *Calopteryx splendens*-group, no structural characters in either sex permit to separate taxa, and inter-species hybridisation is frequent. It takes place in a gradual manner, as if the gene pool of one taxon were progressively diluted into that of the other, and it is expressed - at least in males - in a clinewise contraction or expansion of the wing spot. A spectacular example is provided by the numerous intermediates between *C. waterstoni* Schneider (no wing spot), and *C. amasina* (Sély) (a broad wing spot) (DUMONT et al., 1987). The taxonomic rank of all the forms involved is by no means clear, and species notation is used here as a convenient shorthand only, although it should be stated that in cases where hybrid zones prove to be bigger than those of the "pure" taxon, there is reason to believe in introgression.

Here, we discuss a hybrid zone in the East of the range of *C. orientalis* (Sély), prompted by the discovery, in the collections of the Plant Pest and Diseases Institute of Iran in Teheran, of a male with a distinctive phenotype, collected on 23

March 1965 in Park Golestan, NE Iran. One of us (H.H.) returned to this site, and collected a series of males and females from three stations here. These contained one male and one female similar in phenotype to the one collected thirty years earlier. Additional material from the entire range of *C. orientalis*, as well as a sample of its eastern vicariant, *C. samarcandica* Bartenev, was then collected to form the basis of the present analysis.

MATERIAL EXAMINED

- (1) Lenkoran (southern Azerbaidjan): 2 ♂, 3 ♀ (androchrome), 28-III-1923, A. Shorygin leg. (ex coll. Zool. Inst., Moscow, in coll. H. Dumont)
- (2) Alamdeh (Caspian coast of Iran): 2 ♂, 2 ♀ (androchrome), 18-V-1995, H. Heidari leg.
- (3) Golestan Park (NE Iran): 16 ♂, 21 ♀ (androchrome), including a ♂ and ♀ with hind wing showing a spot extension in the basal half of the wing, asymmetrically in both wings; 27-VI-1995, H. Heidari leg.
- (4) Firuza (Central Kopet Dag, Turkmenistan): 5 ♂, 1 ♀ (gynochrome, but wing tips slightly darkened), 10-V-1995, Kh.I. Atamuradov leg.
- (5) Khodja-Pil (Kugitang area, southern East Turkmenistan): 6 ♂, 4 ♀ (gynochrome), 4-V-1995, Kh.I. Atamuradov leg.
- (6) Rubat-i-Sabzak (W Afghanistan, Harirud valley), 5 ♂, 18-VI-1977, A.M. Simonetta leg. (we examined photographs of wings taken by E. Insom, and kindly provided by F. Terzani).

In addition to a qualitative interpretation of the status of the two peculiar specimens from Golestan, the following male characters were examined quantitatively: (1) number of postnodals (pn) between nodus and commencement of wing spot (measured between C and R), and (2) percentage coverage of postnodal wing zone by spot, expressed as $(b / a + b) \cdot 100$, with b = distance from wing spot margin to wing tip, and a = distance between nodus and wing spot margin. Both are measures of wing spot size. We also measured the length of abdomen (in *orientalis* only, and except Afghan specimens). Statistical testing consisted of ANOVA on (1), and pairwise t-tests to test for the null hypothesis $\mu_1 = \mu_2$, with μ_x = number of pn to wing spot and abdomen length.

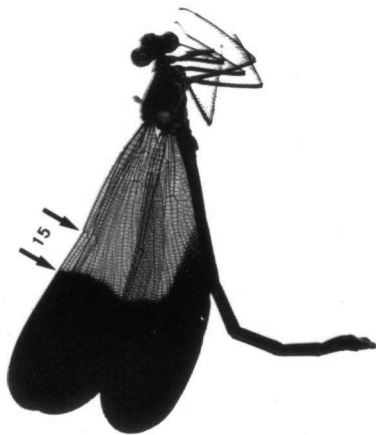


Fig 1. *Calopteryx orientalis* hybrid male from Golestan Park, Iran.

RESULTS

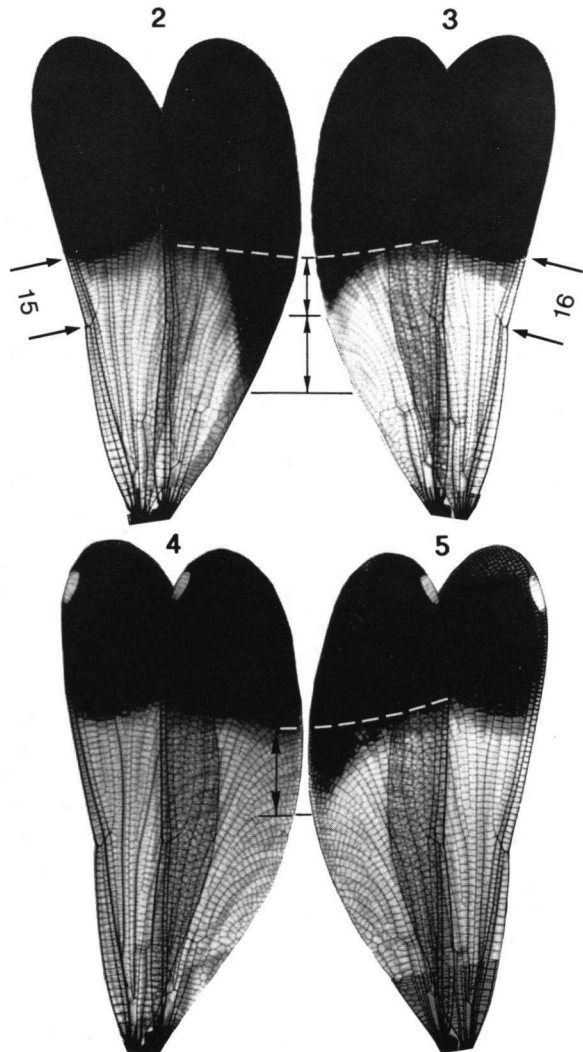
Figures 1-5 show the wing spot pattern of the "special" male and female from Golestan Park. In both, the forewings conform to *C. orientalis*, but both hindwings in the male, and one hindwing in the female have a wing spot which is smeared out basad in its lower half. The maximum extent of the spot in one of the male wings is exactly at the site on the wing margin where it would be expected in *C. samarcandica* (though also in *C. intermedia*). The spot asymmetry and its apparent confinement to the single site of Golestan Park

is puzzling and unexplained. We consider both specimens as hybrids of a particular kind.

An ANOVA reveals that the number of free post-nodals is heterogeneous among the five groups tested (Tab. I). Table II illustrates that the wing spot of the populations from Lenkoran and Alam-deh is not significantly different at $P=0.01$, while Lenkoran is very significantly different from Golestan and Rubat-i-Sabzak (at $P = 0.001$). Firuza is significantly different from all others except Rubat-i-Sabzak; Rubat-i-Sabzak is neither different from Firuza nor from Golestan. This places Firuza in a rather special position: it appears more closely related to the Harirud population than to the ones on the Iranian plateau. Since

Table I
ANOVA for cells between nodus and wing spot

	Sum of squares	df.	Mean square	F value
Treatment	625.11	3	208.37	30.00
Error	263.96	38	6.96	
Total	889.007	41		



Figs 2-5. *Calopteryx orientalis*, hybrids: (2-3) left and right wing pairs of male (same as Fig. 1); - (4-5) left and right wing pairs of female (both Golestan Park, Iran) (note asymmetry between left and right hindwings). - [Numbers of pn indicated (male only). The fuzzy boundary of the wing spots is a photographic artefact (compare with Fig. 1)].

Table II
Summary of male characteristics

Locality	Cells between nodus and forewing spot average (left, right)	a(mm)	b(mm)	c(%)	Length abdomen (mm)
Lenkoran	22 (21, 23)	8	12	60	40.0
	<u>20 (20, 20)</u>	7.5	10.5	<u>58.3</u>	<u>40.5</u>
	$\bar{x} = 21.0; s = 1.41$			$\bar{x} = 59.15$	$\bar{x} = 40.25$
Alamdeh	23 (21, 25)	6.5	12	64.9	40.5
	<u>26 (25, 27)</u>	7	11	<u>61.1</u>	<u>39.5</u>
	$\bar{x} = 24.5; s = 2.52$			$\bar{x} = 63.00$	$\bar{x} = 40.0$
Firuza	13 (14, 12)	3	14	82.3	34.0
	13 (15, 11)	3.5	12	77.4	34.0
	10 (10, 10)	3.5	12.5	78.2	35.0
	10 (10, 10)	2.5	13	83.9	35.5
	<u>10 (10, 10)</u>	3	13.5	<u>81.2</u>	<u>34.0</u>
	$\bar{x} = 11.5; s = 2.00$			$\bar{x} = 80.60$	$\bar{x} = 34.5$
Golestan Park	17 (18, 16)	5.0	14	73.7	41.0
	9.5 (11, 8)	4.0	15	79.0	41.0
	14 (15, 13)	5.0	14	73.7	41.0
	14.5 (14, 15)	5.5	15	73.2	39.0
	10 (11, 9)	5.0	16	76.2	40.0
	13 (13, 13)	4.5	14	75.7	38.0
	14.5 (13, 16)	3.0	16	84.2	40.5
	15 (14, 16)	4.5	15	77.0	42.0
	18 (18, 18)	4.5	15	77.0	40.5
	11 (11, 11)	3.0	15	83.3	41.0
	18.5 (18, 19)	3.5	15	81.1	41.0
	12.5 (12, 13)	4.0	15	79.0	40.5
	<u>15* (15, 15)</u>	5*	16	<u>76.2</u>	-
	14.04; $s = 2.90$			$\bar{x} = 77.80$	$\bar{x} = 40.46$
Rubat-i-Sabzak ⁽¹⁾	12	3.5	11.5	76.7	-
	9	3.0	12.5	81.6	-
	13	4.5	13.5	75.0	-
	7	3.0	20.0	87.0	-
	<u>10</u>	3.5	16.5	<u>82.5</u>	-
	10.20; $s = 2.14$			80.56	

* "special" hybrid male

⁽¹⁾ only one wing available.

Table III
Pairwise t-tests, testing for $\mu_1 = \mu_2$. Variable: number of pn to wing spot, males

Pairs	df.	t-value	Significance
LenKoran-Alamdeh	6	2.42	not significant at $p = 0.01$
Alamdeh-Golestan	28	4.95	significant at $p = 0.005$
Golestan-Firuza	34	2.66	significant at $p = 0.01$
Firuza-Rubat-i-Sabzak	13	0.89	not significant at $p = 0.05$
Rubat-i-Sabzak-Golestan	29	1.63	not significant at $p = 0.05$
Golestan-LenKoran	28	4.66	significant at $p = 0.005$
Firuza-LenKoran	12	9.36	significant at $p = 0.005$
Rubat-i-Sabzak-LenKoran	7	7.94	significant at $p = 0.005$
Alamdeh-Firuza	12	10.95	significant at $p = 0.005$
Alamdeh-Rubat-i-Sabzak	7	8.72	significant at $p = 0.005$

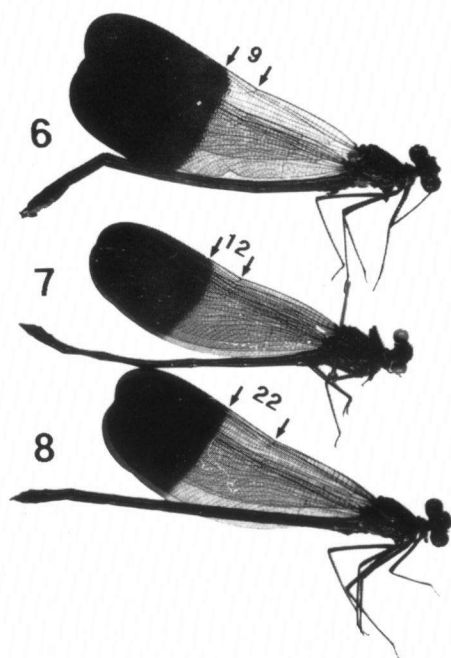
this sample was of recent origin (1995), it may reflect the influence of the Karakumskiy canal on gene flow. In terms of percentage wing coverage by the spot, we find a rather clear west-east trend, with Lenkoran just under 60 %, and Rubat-i-Sabzak just over 80 %. One specimen from Rubat-i-Sabzak had only 6 free postnodals, and a spot covering 87 % of the postnodal wing surface. Individually taken, this specimen would have been hard to identify as *C. orientalis*.

For abdomen length, a character which has been applied (without much foundation, since size has as well a genetic as an environmental component to it) to the subspecific taxonomy of *C. orientalis* by SCHMIDT (1954), a different grouping is obtained; here, only the Firuza population stands out by its smaller size (t-tests: Lenkoran-Alamdeh, df 2, $t = 0.45$, not significant; Golestan not significantly different from either Lenkoran or Alamdeh, but Golestan-Firuza, df 15, $t = 11.48$, significant at $P = 0.001$).

DISCUSSION

While we are currently not in a position to propose a mechanism by which particular phenotypes are produced, it appears that hybridisation is a logical explanation, not only for the two peculiar specimens of Figures 1-5, but for the whole character gradient that was observed (Figs 6-8).

BARTENEV (1930) provided the first (and so far only) map of the range of *C. orientalis*. It occupies a narrow zone on the lower course of a number of - mostly short - rivers draining the Talysh mountains in the West, the Elburz in the centre, and the north flanks of the Kopet Dag in the East. The types of the species, a male and an andro-chrome female (SÉLYS, 1887) were supposed to have come from Krasnovodsk (presently Turkmenbashi), West Turkmenistan but, as will be shown elsewhere (Dumont, in prep.), these were obviously mislabeled. From the central-west Kopet Dag (Geok-Tepe W of Ashgabad), BARTENEV (1913) described *C. transcasica*, which is (by



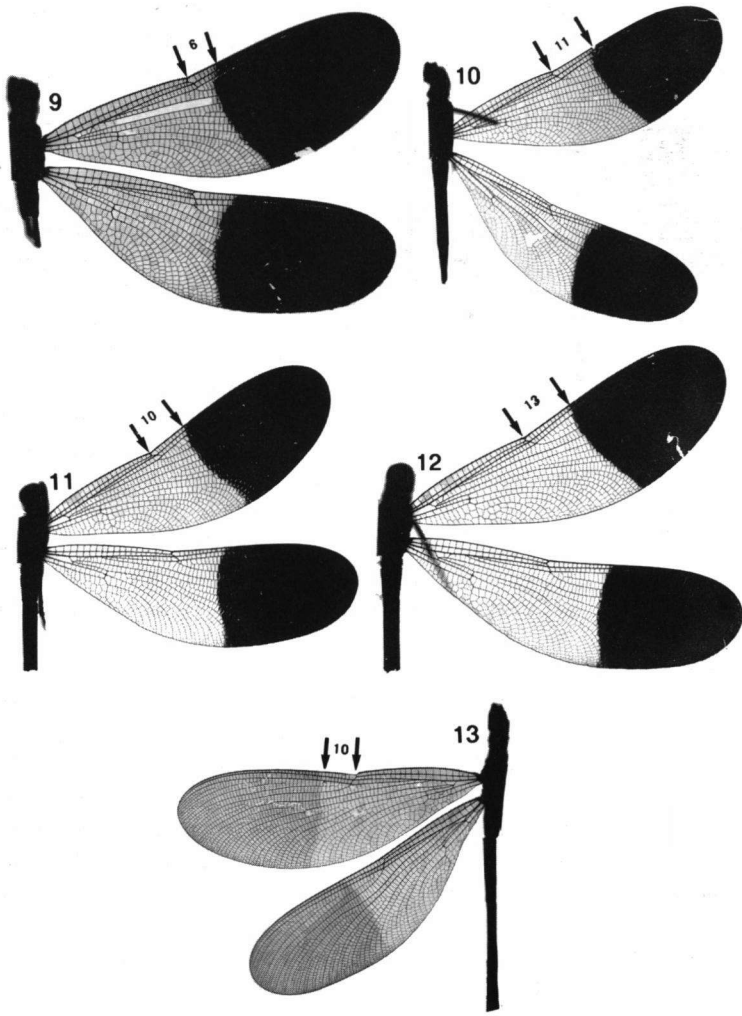
Figs 6-8. Male of *C. orientalis* s.l. from different populations: (6) W Golestan, Iran; – (7) Firuza, Turkmenistan; – (8) Alamdeh, Caspian Coast, Iran. – [Note the E-W-trend in number of pn in the forewing].

range and characterwise) a junior synonym of *C. orientalis*. Curiously, this binomen was left out when SCHMIDT (1954) exploded *C. orientalis* in three subspecies: *C. o. risi* in the West, *C. o. orientalis* in the center, and *C. o. shachrudicus* (BARTENEV, 1916) in the trans Elburz-Kopet Dag zone near Shahrud (presently Emamshahr). Two characters upon which SCHMIDT (loc.cit) based his subdivision, size and the occurrence of androchrome (= homochrome) females, are here shown not to be valid. The ssp. *shachrudicus*, supposedly smaller than the others and without androchrome females, was indeed indistinguishable from all others except Firuza (which was expected to be larger) in size and had only androchrome females. On the other hand, the Firuza populations had a gynochrome (= heterochrome) female, which should not be the case according to Schmidt's key. Thus, only the West-East gradient in wing spot size

remains, yet our evidence for hybridisation as being its cause invalidates the taxic status given to members of that gradient. According to the rules of zoological nomenclature (Article 23 h), hybrids are indeed not eligible for a separate taxonomic status and their names have no right of priority.

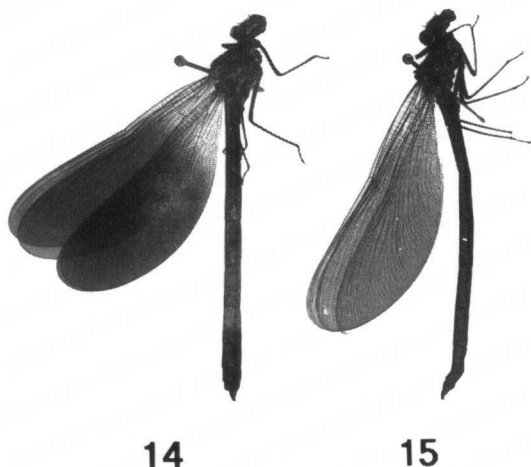
Two far eastern records of *C. orientalis*-like animals are by SCHMIDT (1961) from the area of Herat in the Harirud valley in Afghanistan, this time under the trinomen *C. o. transcaspica* (but without figure or description), and the small series from Rubat-i-Sabzak, restudied here (Figs 9-13), first recorded by CARFI et al. (1982) under the nominal subspecies' name. Both evidently are hybrid populations too.

The question remains, which member of the *splendens*-group is available for *C. orientalis* to hybridise within the eastern part of its range. All hybrids invariably have wing spots extending to the apex of the wings, and this reduces the choice to *C. samarcandica* and *C. intermedia*. *C. intermedia* (under the trinomen *persicum*, referring to a form with relatively restricted wing banding, the spot extending only some six cells basad to the nodus) has only been recorded once from West Afghani-



Figs 9-13. Males of *C. orientalis* s.l. from Rubat-i-Sabzak, Afghanistan. Note the variation in the number of pn.

stan by SCHMIDT (1961): a couple from Qades (Qal'eh-ye Now, $35^{\circ} 27' \text{N}$, $67^{\circ} 08' \text{E}$). This locality, although little more than 100 km NE of Herat, belongs to the catchment of the Murgab, a river which, like the Harirud-Tedzhen, ends blindly in the Karakum desert. Chances are (but fresh material in support is desirable) that the local *Calopteryx* is a hybrid which is phenotypically even closer to *C. samarcandica* than all material examined here. *C. samarcandica*, in pure form, appears restricted to the valley of the Amu-Darya and major tributaries. The specimens from Khodja-



Figs 14-15. Males of *C. samarcandica* from Khodja-Pil, Kugitang, East Turkmenistan: – (14) almost mature male; – (15) freshly emerged male.

-Pil (Figs 14-15) are geographically the closest to *orientalis* currently on record. They display the typical characters of the taxon: broad wings with an extensive brownish spot that is vaguely delimited towards the wing base, and freshly emerged males with brownish-tinged wings but no wing spot discernable. It should be noted in passing that BARTENEV (1913) was probably correct in synonymising *C. unicolor* with *C. samarcandica*. However, this did not give him the right to change its name to

maracandica, which is thus an objective junior synonym to *samarcandica*. In the Syr-Darja catchment, and East of it, hybrids between *C. samarcandica* and yet other forms of *C. splendens* occur, which will require further study at a later date.

We conclude that, in pure form, *C. orientalis* only occurs in a narrow coastal strip along the south Caspian. Populations along the north Kopet Dag chain begin to show signs of a transition. South and East of it, they acquire more *samarcandica*-like phenotypic traits as one moves across the Harirud-Tedzhen and Murghab catchments.

Finally, we stress the possible (and likely) effect of the construction of the Karakumskiy Canal, which links the Amu-Darya to the Atrek in the West, cutting through the Tedzhen and Murghab. This provides an artificial pathway for two-way gene migration in *Calopteryx*, the result of which may already be felt north of the Kopet Dag, and may ultimately lead to a disappearance of pure *samarcandica*, as *orientalis* genes flow into the Amu Darya valley.

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