

DRAGONFLY EMERGENCE FROM AN ARTIFICIAL POND IN THE URBAN AREA OF CORDOBA, ANDALUSIA, SOUTHERN SPAIN: A POSSIBLE CASE OF INTRAGUILD PREDATION AND COMPETITION BETWEEN LARVAE

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Abstract – Exuviae of *Anax imperator*, *Crocothemis erythraea*, *Tarnetrum fonscolombii* and *Trithemis annulata* were collected from May to Oct. 1992. *T. annulata* was the most abundant (87.18%); in this sp. ♂ exuviae were significantly more heavy (dry weight) than ♀ exuviae. Values for sex ratio at emergence are given. In the 3 libellulids a slightly higher number of ♂♂ were recorded.

Introduction

The aim was to study seasonal patterns of emergence of Odonata occupying a man-made pond in southern Spain and to determine those species that are able to make use of this type of environment. The pond is located in a small garden in the urban area of Cordoba. It is rectangular (25 x 50 m), lined with concrete, and its depth is about 1 m. No emergent or submerged vegetation is present. The pond contains no fish.

Methods and results

From late April to mid October 1992 the pond was visited 29 times to collect exuviae. All exuviae were later identified and sexed in the laboratory. At each visit water temperature, measured to the nearest 0.5° C, was recorded between 0800 and 1000 G.M.T. The highest water temperature recorded was 24° C (Sept. 6) and the lowest was 10° C (May 7 and 18). The first exuviae were collected on 1st May and emergence was completed by 10th October. 1,974 exuviae, referable to four species were collected, viz. *Trithemis annulata* (Pal. de Beauv.) (87.18%), *Crocothemis erythraea* (Brullé) (7.39%), *Tarnetrum fonscolombii* (Sél.) (5.31%) and *Anax imperator* Leach (0.10%). Only two exuviae of *A. imperator* (both female) were found (Aug. 30, Sept. 13). Number

of exuviae collected each sample day (males and females separately) of the three more common species is shown in Table I.

Crocothemis erythraea

The first exuviae was found on 1st May (1 ♀); emergence was completed by 10th October (2 ♂). One emergence peak was recorded on 26th September (10 ♂, 21 ♀). The total number of exuviae found was 146 (80 ♂, 66 ♀); thus the sex ratio at emergence was 1.212 ♂:1 ♀ (54.79% ♂). This is not significantly different from equality ($\chi^2(1)=1.342$, $0.20 < P < 0.30$). Median emergence on 6th September for males and between 13th and 20th September for females. Males appeared to emerge slightly earlier than females.

Tarnetrum fonscolombii

The first exuviae were found on 1st May (2 ♂); emergence was completed by 5th October (2 ♂). One emergence peak was recorded on 26th September (the same day as for *C. erythraea*): 14 ♂ and 10 ♀. The total number of exuviae found was 105 (54 ♂, 51 ♀); thus the sex ratio at emergence was: 1.058 ♂:1 ♀ (51.42% ♂), and is not significantly different from equality ($\chi^2(1)=0.084$, $0.70 < P < 0.90$). Median emergence between 9th and 23th August for males and 6th September for females. As for *C. erythraea*, males appeared to emerge slightly earlier than females.

Trithemis annulata

The first exuviae were found on 1st May (1 ♂, 1 ♀); emergence was completed by 10th October (8 ♂, 4 ♀). Two emergence peaks were recorded, one on 2nd August (56 ♂, 60 ♀) and a much larger one on 26th September (225 ♂, 202 ♀). The total number of exuviae found was 1,721 (897 ♂, 824 ♀). The sex ratio at emergence was 1.088 ♂:1 ♀ (52.12% ♂), and is not significantly different from equality ($\chi^2(1)=3.096$, $0.05 < P < 0.10$). Median male and median female emerge on same day (20th September) in this

Table I. — Number of libellulid exuviae collected during the emergence season, 1992

Date	<i>C. erythraea</i>		<i>T. fonscolombii</i>		<i>T. annulata</i>	
	♂	♀	♂	♀	♂	♀
1-V	-	1	2	-	1	1
7-V	-	-	-	-	3	-
10-V	-	-	-	-	1	1
18-V	-	-	-	-	3	4
22-V	-	-	-	-	2	5
27-V	-	-	-	-	2	-
31-V	-	-	-	-	2	2
6-VI	-	-	4	4	4	5
13-VI	-	-	-	-	4	7
20-VI	-	1	6	3	1	-
25-VI	-	-	4	7	1	-
5-VII	1	1	-	-	8	26
11-VII	-	-	-	-	9	14
17-VII	-	3	-	-	25	34
25-VII	7	3	-	-	31	33
2-VIII	-	4	7	3	56	60
9-VIII	10	2	4	2	62	32
23-VIII	5	1	5	-	17	14
30-VIII	12	6	1	-	38	19
6-IX	11	5	-	10	75	50
13-IX	3	6	-	-	72	50
20-IX	6	1	-	11	93	78
26-IX	10	21	14	10	225	202
30-IX	8	10	5	1	117	164
5-X	5	1	2	-	37	19
10-X	2	-	-	-	8	4

Table II. — *T. annulata*: mean (S.E.) and median dry weights (mg) of exuviae, after they were maintained during 48 h at 70°C — [n=15 per sample/sex]

Date	Males		Females	
	Mean	Median	Mean	Median
17-VII	2.66 (0.06)	2.7	2.52 (0.05)	2.6
2-VIII	2.70 (0.08)	2.8	2.52 (0.10)	2.4
30-VIII	2.75 (0.05)	2.9	2.63 (0.09)	2.6
13-IX	2.75 (0.09)	2.8	2.76 (0.06)	2.6
26-IX	2.76 (0.05)	2.8	2.58 (0.06)	2.5
5-X	2.56 (0.06)	2.5	2.56 (0.08)	2.5

species.

From each one of six samples collected between 17th July and 5th October, one group of 15 male exuviae and one group of 15 female exuviae were selected, maintained for 48 h at 70°C and then weighed. Mean (\pm S.E.) and median exuviae dry weights (mg) of males and females are shown in Table II. Slight increase in mean exuviae dry weight up to 13th September followed, especially for female exuviae, by a decline later is observed. Male exuviae were significantly heavier than female exuviae (δ mean=2.70 \pm 0.03 (S.E.); φ mean=2.59 \pm 0.03 (S.E.); Mann-Whitney U-test = -2.79, n = 90 δ + 90 φ , P < 0.05). The weight distributions differ in shape (Fig. 1) (Kolmogorov-Smirnov 2-sample test, Z =0.244, P < 0.05). There is less variation in the male exuviae weights than in the female exuviae weights.

Discussion

In the three libellulid species there was a slight excess of males (none of the ratios was significant), which is not frequent in Anisoptera (CORBET, 1980).

Although for these three species the shapes of the emergence date distribution were very similar, one obvious fact is the high number of *Trithemis annulata* exuviae, species dominating throughout the entire emergence period (Fig. 2). This species is widely spread throughout Africa and Asia Minor but has only recently invaded the Iberian peninsula (cf. LIEFTINCK, 1979; FERRERAS-ROMERO, 1981). Its population dynamics in southern Spain suggest the possibility of more than one generation per year (AGÜERO-PELEGREN & FERRERAS-ROMERO, 1992). Its expansion to more northerly parts is rapid and it has recently been found in Huesca (northern Spain) near the Pirineos Mountains (VASCO-ORTIZ, 1991).

Among species with similar ecological characteristics, temporal separation is important for decreasing or eliminating inter-specific competition (BENKE, 1970), thus favouring their co-existence (JOHANNSSON, 1978). Evidently, in the pond studied, there is no such temporal separation of co-existing species. Possibly the most recent species in communities of this type of environment in the Iberian peninsula, i.e. *T. annulata*, is showing a strategy which will ultimately displace the other species.

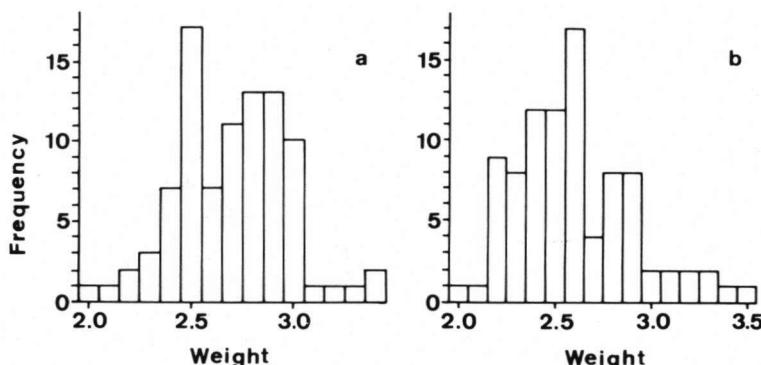


Fig. 1. *Trithemis annulata*: distribution of exuviae dry weights, from 6 samples (July 17-Oct. 5): (a) males, n =90; — (b) females, n =90.

Several studies have recently shown that invasion by a potentially influential species give rise to gradual decline in abundance of resident species. The presence of the larvae of invader species can lead to the reduction in foraging rates (WISSINGER & McGRADY, 1993) and to the change in diet (MAHATO & JOHNSON, 1991) of the resident species larvae; this might result in reduced growth rates, extended development times, and in a reduced survival (CROWLEY et al., 1987). It is also possible that predation by *Trithemis* larvae on the smaller larvae of *Crocothemis* and *Tarnetrum* is partially responsible for the lower abundance of resident species; the direct competitive effect of intraguild predation

should be unbalanced with asymmetric benefits to invader species (MAHATO & JOHNSON, 1991; WISSINGER & McGRADY, 1993).

References — AGÜERO-PELEGREN, M. & M. FERRERAS-ROMERO, 1992, *Opusc. zool. flumin.* 83: 1-7; — BENKE, A.C., 1970, *Ecology* 51: 328-331; — CORBET, P.S., 1980, *A. Rev. Ent.* 25: 189-217; — CROWLEY, P.H., R.M. NISBET, W.S.C. GURNEY & J.H. LAWTON, 1987, *Adv. ecol. Res.* 17: 1-59; — FERRERAS-ROMERO, M., 1981, *Boln Asoc. esp. Ent.* 4:

191-193; — JOHANSSON, O.E., 1978, *Oecologia* 32: 303-321; — LIEFTINCK, M.A., 1979, In: J.A. Guldemand, R. Leys, J.G.M. Notenboom & A.W. Wesselo, [Eds], *Biospeleologische expeditie Algerije 1978*, p. 108, Biospeleol. Werksgroep, Wageningen; — MAHATO, M. & D.M. JOHNSON, 1991, *J. N. Am. benthol. Soc.* 10(2): 165-176; — VASCO-ORTIZ, C.A., 1991, *An. Biol.* 17: 89-90; — WISSINGER, S. & J. McGRADY, 1993, *Ecology* 74(1): 207-218.

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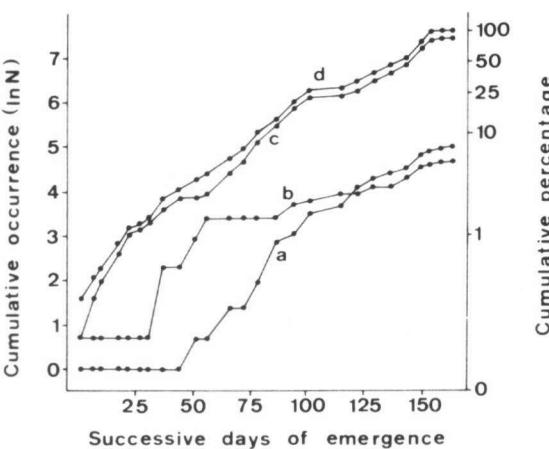


Fig. 2. Emergence curves (a-c) and cumulative percentage of the collected libellulid exuviae (d): (a) — (b) — (c)