Odonatologica 10 (3): 179-187 *September 1, 1981*

SEASONAL INCIDENCE OF ANISOPTERA IN LIGHT-TRAPS IN TRINIDAD, WEST INDIES

Philip S. CORBET
Department of Applied Biology, University of Cambridge,
Pembroke Street, Cambridge, CB2 3DX, United Kingdom*

Received February 20, 1981

Forty-nine Anisoptera, comprising 19 sp. and 13 genera, were captured on about 11% of nights at risk in 2 light-traps operated nightly in Trinidad for 14 months. Most spp. and individuals were captured during the rainy season (June through December). 'Older' adults predominated in catches at the beginning and end of the rainy season, and 'younger' adults about 3 months after its onset. The results are consistent with the assumption that old adults, having retired to shaded refuges, provide continuity during the dry season and then, at the start of the rains, become active in exposed situations and promptly reproduce, adults of the ensuing generation emerging 2-4 months later.

INTRODUCTION

Adult dragonflies, especially Anisoptera, are sometimes captured in light traps, mainly soon after sunset, but occasionally also close to sunrise. If such a trap is near an emergence site in low latitudes, the adults caught near sunrise are often teneral, having presumably been attracted to the trap during the maiden flight (P.S. Corbet, unpublished observations).

The phenology of dragonflies in regions with seasonal rainfall in the tropics is poorly understood. When I learnt that light-traps were being operated nightly by staff of the Commonwealth Institute of Biological Control (C.I.B.C.) at Curepe, Trinidad, I asked Dr F.D. Bennett if all the Odonata caught during 14 months could be preserved and sent to me; I hoped that the

* Present address: Department of Biological Sciences, The University, Dundee, DD1 4HN, United Kingdom

dates of capture and relative ages of the specimens might provide information about the seasonal ecology of dragonflies in that environment. Dr Bennett kindly complied with my request, and I present here the outcome of the resulting study. Although only 49 specimens were captured, their seasonal incidence and condition proved informative, thus confirming the value of light-traps for investigations of this kind.

METHODS

The two light-traps (A and B) in which the dragonflies were collected were operated in Curepe, Trinidad at 61°23'W, 10°39'N. Both were modified Robinson traps (ROBINSON & ROBINSON, 1950) with a 125-watt black-light bulb protruding about 10 cm above the rim and vanes of the trap; the funnel diameter was 76 cm at the top and 10 cm at the bottom; and the funnel contained six vanes flush with its rim. Each trap sat upon a metal cylinder about 0.8 m in diameter, so that the rim of the trap was about 91 cm above the ground. Both traps contained netting or baffles designed to prevent insects damaging themselves after capture, and the specimens of Odonata were usually alive and in good condition when removed from the trap 1-2 hours after sunrise. Throughout this study (June 1, 1970 to July 31, 1971) both traps operated nightly except that trap B failed to function on 8 nights (during January, February and May 1971) and trap A failed to function on about the same number of nights, though perhaps (in the absence of precise information) on fewer. It was assumed that both traps were at risk on 357 nights during the study period. Each trap was switched on at least 30 minutes before sunset and switched off about 1-2 hours after sunrise.

No major rivers, swamps, large ponds or forests were within 2-3 km of either trap site. Trap A was on the C.I.B.C. premises in Gordon Street; it stood on a lawn among scattered trees and bushes. Nearby were 22 small, open, experimental, water tanks (approximate dimensions, in m: depth 0.4, area 0.9 x 2.1 (10 tanks); and depth 0.3, area 0.4 x 0.9 (12 tanks)) in which grew rich stands of *Salvinia* and *Eichhornia*. Within 50 m of the trap was an open drain, swollen in the rainy season and otherwise completely dry. Neither of these water bodies is likely to have provided a larval habitat for other than the occasional dragonfly of species obtained in trap A. Trap B was at Santa Margarita Circular Road on a paved driveway, less sheltered by trees than was trap A, and on foothills ca 100 m above it. Trap B stood about 5 m east of a two-storey garage and 1.5 m from terraced retaining walls 3.5 m high.

All Odonata found in the traps were stored in paper envelopes and later identified and sexed; representative specimens of all species encountered were later checked by Professor Minter J. Westfall Jr. Each adult was also assigned to a broad 'age' category based on the condition of the margins of the wings, as

follows: category *a* — fresh, unworn; *b* — somewhat worn; *c* — extensively worn. For analysis, categories *b* and *c* were combined. In addition it was noted whether individuals were teneral, and account was taken of the intensity of wing pigmentation and (for female aeshnids) of the presence on the compound eyes of copulation marks (viewed at x40 magnification), of the soiling of the apical segments of the abdomen, and of the integrity of the anal appendages (cf. CORBET, 1962; PAULSON, 1966; DUNKLE, 1979). Unfortunately we must allow the possibility that anal appendages can become damaged under circumstances other than oviposition (e.g. perhaps in a trap after capture): a male *Gynacantha nervosa* taken inside a house at Balandra (see below) had broken anal appendages. The age-determination was undertaken provisionally by Ms Terèse Butler (without knowledge of the times of rains in Trinidad or of an hypothesis regarding the seasonal distribution of young and old specimens) and later checked independently by me. Only 1 adult was assigned to a different age category as a result of this check.

Material from both traps was combined for analysis. Supplementary information derived from 5 Anisoptera taken elsewhere at light during the study period is included in this paper, but not in the analyses.

At Curepe, the (single) rainy season each year begins between mid-May and early June, and lasts until late December to mid-January. Records of rainfall during the study period were obtained from a raingauge at the University of the West Indies, about 1.5 km south of the trap sites.

RESULTS

The following analysis refers only to specimens caught in traps A and B between June 1, 1970 and July 31, 1971 inclusive.

During the 12 months beginning June 1, 1970 Odonata were caught on 39 nights (ca 11% of nights at risk); 35 of these nights were during the "rainy season" (June through December; cf. Fig. 1), 27 being during the first part of it (June through October). During these first 5 months of the rainy season in 1970 the 2 traps (combined) were catching on average 6.0 Anisoptera per month and catching them on 5.4 nights per month. During the 7 succeeding (drier) months, corresponding values were 1.7 and 1.7 respectively.

The Odonata collected (Table I) comprised 49 specimens (all Anisoptera), belonging to 19 species, 13 genera and 2 families (Aeshnidae and Libellullidae). Only 4 species were represented by more than 2 specimens, namely: *Orthemis ferruginea* (13 specimens), *Coryphaeschna viriditas* (8), *Tramea calverti* (6) and *Gynacantha nervosa* (5).

The number of species and the number of individuals is high soon after the onset of the rains and holds this value, perhaps increasing slightly, until

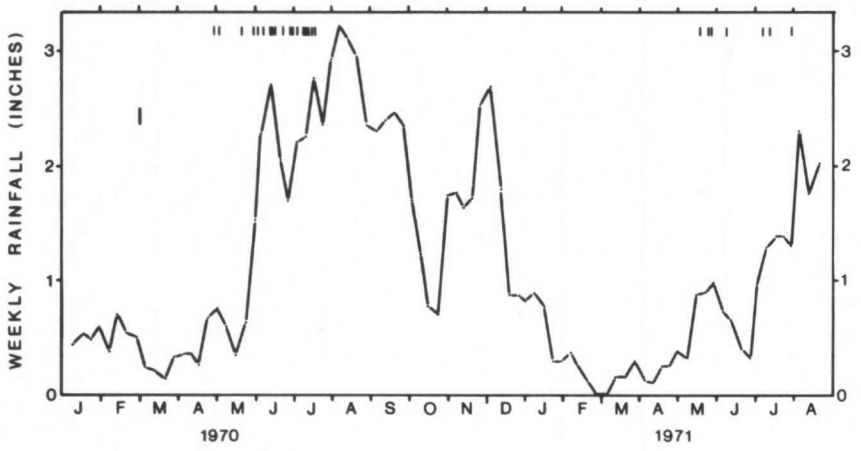
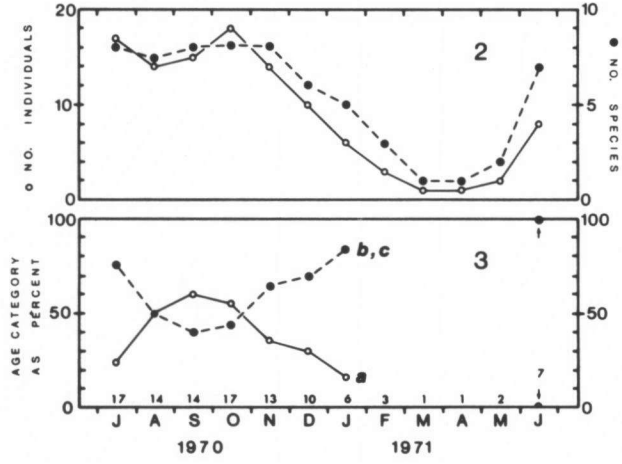


Fig. 1. Rainfall recorded weekly at the University of the West Indies, St. Augustine, Trinidad during the study period. Records are shown as 3-weekly running means. Days when "heavy" rain (i.e. 0.47 - 1.50 inches in 24 hours) fell during May through July are indicated as vertical marks near the upper abscissa.



Figs. 2-3. Seasonal incidence of Anisoptera in light-traps in Trinidad during the study period, expressed as 3-monthly running totals. (Numbers near the lower abscissa show the sample sizes): (2) species and individuals; — (3) adults classified as 'younger' (category *a*) and 'older' (categories *b* and *c*).

October or November; thereafter it declines steadily until the onset of the next rains in May (1971) whereupon it rises abruptly (Fig. 2).

In all species combined, the sexes were about equally represented and showed no detectable differences in seasonal incidence — either in aggregate

Table 1

Species and numbers of Anisoptera caught in light-traps at Curepe, Trinidad, June 1, 1970 to July 31, 1971

Species	Numbers caught						Months during which captured[3]
	Trap A		Trap B		Totals		
	♂	♀	♂	♀	♂	♀	
Anatya guttata (Erichson)	—	—	—	1	—	1	*10*
Brachymesia furcata Hagen[2]	—	1	—	—	—	1	1
B. herbida Gundlach	1	—	—	—	1	—	*12*
Coryphaeschna viriditas Calvert[1]	3	5	—	—	3	5	*6*, 7, 8, *9*, *12*
Erythrodiplax connata fusca (Rambur)	1	—	—	—	1	—	*1*
E. umbrata (Linnaeus)[1]	—	—	1	—	1	—	2
Gynacantha mexicana Selys[2]	1	—	—	—	1	—	7
G. nervosa Rambur[1]	3	—	1	1	4	1	*6*, 7, *10*
Micrathyria atra (Martin)	—	—	—	1	—	1	*11*
M. laevigata Calvert	—	1	—	—	—	1	7
M. ocellata dentiens Calvert	1	1	—	—	1	1	*6*
Orthemis ferruginea (Fabricius)	5	3	3	2	8	5	*6*, 7, *9*, *10*, *11*
O. sulphurata Hagen	—	2	—	—	—	2	*6*, 7
Pantala flavescens (Fabricius)[1]	—	—	1	—	1	—	*6*
Perithemis mooma Kirby	—	—	1	—	1	—	*5*
Tauriphila australis (Hagen)[2]	—	—	1	—	1	—	10
Tholymis citrina Hagen[2]	—	1	—	—	—	1	9
Tramea calverti Muttkowski	1	3	1	1	2	4	*6*, 7, 9, *10*
Triacanthagyna septima (Selys)	—	1	—	—	—	1	*8*
Totals	*16*	*18*	*9*	*6*	*25*	*24*	

[1] Phenological data exist for these species for southern Florida, U.S.A. (PAULSON, 1966).
[2] Species not listed for Trinidad by GEIJSKES (1932).
[3] Records which extend those of GEIJSKES (1932) are shown in italics.

or for the commonest species considered separately.

'Younger' adults (i.e. those in category *a*) are poorly represented soon after the beginning of the rains; thereafter their numbers rise decisively to reach a peak centred on September, and then decline rapidly (Fig. 3). The remaining 'older' adults (i.e. those in categories *b* and *c* combined), which of course comprise the complement of the younger ones, are best represented at the beginning and end of the rains; their numbers decline rapidly soon after the

onset of the rains, a trend not reversed until August to October. In case future observations throw light on their status, I list here the only 4 specimens in category *a* encountered early in the rainy season (i.e. in June, July and August 1970). They were: *Tramea calverti* and *Triacanthagyna septima* both female, June 14; *Micrathyria ocellata dentiens* female, June 16; and *Gynacantha mexicana* male, July 13. Only 1 specimen (*Orthemis ferruginea* male, September 3) was near to being teneral.

Indicators of female reproductive condition of 2 species of aeshnid were as follows. *Coryphaeschna viriditas*: only 1 female (August 11) possessed a detectable (though poorly defined) copulation mark, this female being among the 4 which had a soiled abdomen (June 20 to September 28, 1970); and all 5 had broken or missing anal appendages. *Gynacantha nervosa*: the only female (October 13) lacked a copulation mark, but had a soiled abdomen and broken anal appendages.

All specimens of *Coryphaeschna viriditas* had the wings heavily and evenly pigmented except 3 females which had wings that were almost unpigmented (June 9 and July 10, 1970) or amber only at the base (September 28) — like the specimen described by DUNKLE (1979). In the male *Erythrodiplax umbrata* (February 12) there were only incipient transverse dark bands on the wings, and the thorax and abdomen were still yellowish green and ochreous.

Five specimens of Odonata (not included in the foregoing analyses) were caught at light elsewhere during the study period: *Coryphaeschna viriditas* — female, on the ground by trap A, July 10, 1970, category *b*, no copulation mark, soiled abdomen, broken anal appendages; *Erythrodiplax umbrata* — male, Balandra, August 20, category *b*, pronounced transverse dark bands on wings, thorax dark; *Gynacantha mexicana* — male, Balandra, August 31, category *a*; *Gynacantha nervosa* — male, Balandra, August 28, category *c*; and male, in house near trap B, June 4, category *b*, broken anal appendages.

DISCUSSION

Fifteen of the 19 species encountered in this study are listed for Trinidad by GEIJSKES (1932) and for some species these data extend his seasonal range of records (cf. Tab. I). Most of the species encountered in this study occur widely through the West Indies and tropical America (cf. KLOTS, 1932; WILLIAMS, 1937; WESTFALL, 1960; D.R. Paulson, 1980, pers. comm.) and pond-dwelling species are well represented among them (cf. WILSON, 1911; DONNELLY, 1970). Indeed, all the species in Table I except 6 (*Anatya guttata, Erythrodiplax connata fusca*, the 3 *Micrathyria* spp. and *Perithemis mooma*) are reported to range widely away from water (D.R. Paulson, 1980, pers. comm.). Noteworthy among them are: *Brachymesia furcata*, known to disperse widely (DONNELLY, 1970); *Erythrodiplax umbrata*, encountered

at light 16 km offshore in the Caribbean Sea by GEIJSKES (1967); and *Gynacantha nervosa*, known to oviposit in a variety of open situations (WILLIAMSON, 1923; WILLIAMS, 1937). Phenological data for 7 of the species in southern Florida, U.S.A. have been recorded by PAULSON (1966) (cf. Tab. I).

Information relating to seasonal rainfall areas in the Old World tropics, and which I have already reviewed (CORBET, 1962, 1980), supports the following conclusions. The Anisoptera inhabiting temporary bodies of water in such areas pass the dry season as adults, appearing near water promptly after the start of the rains, and soon or immediately copulating and ovipositing there. Some (e.g. *Gynacantha* spp.) spend the dry season as matures in forest or woodland; others (e.g. *Hemianax, Pantala*), which are obligate migrants, follow the seasonal movements of the Inter-Tropical Convergence Zone (I.C.T.Z.), thus being transported each generation to places where rain is about to fall. In both cases eggs laid at the beginning of the rains yield adults 2 or more months later (see especially STORTENBEKER, 1967). These adults then pass the ensuing dry season locally or are transported to another rainfall area by the I.C.T.Z.

Corresponding information from the New World tropics (DUNKLE, 1976; MORTON, 1977; D.R. Paulson, 1980, pers. comm.), though less extensive or straightforward, is consistent with these conclusions. So the results presented here can now be examined for their degree of correspondence with the expected pattern. (An obvious, but unavoidable, shortcoming of these data is that they are aggregated, a circumstance that will mask the expression of differing seasonal patterns among the species represented.)

The seasonal distribution of species, individuals, and 'younger' and 'older' specimens (Figs. 2-3) is consistent with these inferences: mature adults provide continuity in the dry season during which they are seldom encountered in exposed situations; most adults reproduce soon after the beginning of the rains and their progeny begin to emerge as adults 2-4 months later (*Gynacantha nervosa* can complete a generation in 2½ months in Guatemala (WILLIAMS, 1937)), to survive the next dry season as matures.

Several aspects of the results reported here deserve further comment.

The age-grading data for *Coryphaeschna viriditas* and *Gynacantha nervosa* show that during the first half of the rainy season adults are reproductively active and also that copulation marks can often be absent or undetectable in females which (to judge from the soiling of the abdomen) have already oviposited. These findings are consistent with those of DUNKLE (1979) who found "no definite mating marks" in 3 female *C. viriditas* and 10 female *G. nervosa*.

The condition of the captures supports the assumption that the traps were remote from emergence sites and shows that they were sampling

predominantly post-teneral adults active in exposed situations. As already noted, several of the species caught are known to disperse widely in the West Indies. This they appear to do mainly during the rainy season, issuing then from the woodland sites which supposedly provide dry-season refuges for the adult stage.

The finding in Trinidad by GEIJSKES (1932) of a teneral *Triacanthagyna septima* in March exposes the possibility that some species at least are not strictly univoltine, and that mature adults, and perhaps especially gravid females, may be opportunistic — exploiting water when they find it — but that adults emerging during the dry season may repair immediately to woodland, remaining there until the first heavy fall of rain sees their appearance again in exposed situations. A matter deserving close attention is the stimuli which induce adults to become active over open ground at the onset of the rains (cf. DUNKLE, 1976). Could one of them be the wider distribution of their food?

It is to be expected that most accounts of the phenology of Odonata in the tropics will be anecdotal or based on brief periods of observation. But present knowledge makes it likely that a programme of systematic observations, conducted simultaneously inside woodland and in open situations at potential oviposition sites, and continuing for at least 14 months, would rapidly and significantly improve our understanding of the seasonal ecology of dragonflies in the tropics.

ACKNOWLEDGEMENTS

Several people gave valued help during this study: Dr F.D. BENNETT, Director, C.I.B.C., and Dr. R.E. McFADYEN (née CRUTTWELL) collected and preserved the material and provided background information; Ms Terèse KING (née BUTLER) provisionally determined the species and age category of specimens; Professor Minter J. WESTFALL Jr. checked and corrected identifications; and Dr D.R. PAULSON shared with me his extensive knowledge of Neotropical Odonata. For reviewing the typescript I also thank: Drs F.D. BENNETT, S.W. DUNKLE and D.R. PAULSON, Mr R.J. ROWE and Professor Minter J. WESTFALL Jr.

While preparing this paper I received financial support from the Association of Commonwealth Universities.

REFERENCES

CORBET, P.S., 1962. *A biology of dragonflies.* Witherby, London.

CORBET, P.S., 1980. Biology of Odonata. *Ann. Rev. Ent.* 25: 189-217.

DONNELLY, T.W., 1970. The Odonata of Dominica, British West Indies. *Smithson. Contrib. Zool.* 37, 20 pp.

DUNKLE, S.W., 1976. Notes on the Anisoptera fauna near Mazatlan, Mexico, including dry to wet seasonal changes. *Odonatologica* 5 (3): 207-212.

DUNKLE, S.W., 1979. Ocular mating marks in female nearctic Aeshnidae (Anisoptera). *Odonatologica* 8 (2): 123-127.

GEIJSKES, D.C., 1932. The dragonfly-fauna of Trinidad in the British West Indies (Odonata). Part II: Anisoptera. *Zool. Meded., Leiden* 15 (1/2): 96-128.

GEIJSKES, D.C., 1967. Libellen gevonden op zee in het Caribisch gebied. *Ent. Ber., Amst.* 27: 221-223.

KLOTS, E.B., 1932. Insects of Porto Rico and the Virgin Islands. Odonata or dragonflies. *Scient. Surv. P. Rico* 14 (1): 1-107, 6 pls.

MORTON, E.S., 1977. Ecology and behavior of some Panamanian Odonata. *Proc. ent. Soc. Wash.* 79 (2): 273.

PAULSON, D.R., 1966. *The dragonflies (Odonata: Anisoptera) of southern Florida.* Ph. D. Thesis, Univ. Miami, Coral Gables.

ROBINSON, H.S. & P.J.M. ROBINSON, 1950. Some notes on the observed behaviour of Lepidoptera in flight in the vicinity of light-sources together with a description of a light-trap designed to take entomological samples. *Ent. Gaz.* 1: 3-20.

STORTENBEKER, C.W., 1967. Observations on the population dynamics of the Red Locust, Nomadacris septemfasciata (Serville), in its outbreak areas. *Agric. Res. Rep., Wageningen* 694, 118 pp.

WESTFALL, M.J., 1960. The Odonata of the Bahama Islands, the West Indies. *Am. Mus. Novit.* 2020, 12 pp.

WILLIAMS, F.X., 1937. Notes on the biology of Gynacantha nervosa Rambur (Aeschninae), a crepuscular dragonfly in Guatemala. *Pan-Pacif. Ent.* 13 (1/2): 1-8.

WILLIAMSON, E.B., 1923. Notes on American species of Triacanthagyna and Gynacantha. Misc. Publs Mus. Zool. Univ. Mich. 9, 80 pp., 7 pls.

WILSON, C.B., 1911. Notes on dragonflies of Jamaica. *Johns Hopkins Univ. Circ.* 1911 (Feb.): 1-4.