Dragonfly emergence at a small newly-created pond in Hong Kong

Graham Reels
H-3-30, Fairview Park, Yuen Long,
N.T., Hong Kong.
email: gtreels@cyberdude.com

Abstract

Dragonfly (Odonata: Anisoptera) emergence was monitored at a small (0.02ha) pond in Hong Kong from March 2004 to July 2005. The pond was created in late 2003, with emergent vegetation established along the margin.

Dragonfly exuviae were much more abundant in 2004 (597 exuviae in 12 species) than in 2005 (49 exuviae in three species). Exuviae abundance was highest in March in 2004; April in 2005. In 2004, exuviae were recorded until September; in 2005, they were not recorded after May. Exuviae were estimated to have an average persistence of 3.4 days in the field.

Emergence patterns varied between species. Most aeshnids and libellulids emerged in March and April 2004, although *Anax guttatus* had a second pulse of emergence in June 2004; *Sinictinogomphus clavatus* and *Ictinogomphus pertinax* (Gomphidae), and *Epophthalmia elegans* (Corduliidae) were late emergers in 2004, their exuviae first appearing in June or July. The two gomphid species emerged in greater numbers in April and May 2005.

The dramatic decline of emergence in 2005 was probably due to the growth and proliferation of predatory fish in the pond.

More dragonfly species were recorded as adults than as exuviae, suggesting adult immigration. Surveys of adult dragonflies alone may not give a completely accurate impression of the value of particular ponds for breeding dragonflies.

Key words: Odonata, dragonflies, Anisoptera, Hong Kong, exuviae, emergence, pond.

Introduction

The colonisation by dragonflies (Odonata: Anisoptera) of newly-created wetlands was until recently poorly-studied in Hong Kong. Prior to the present study, no systematic attempt had been made to monitor dragonfly emergence, by identification and counting of exuviae, at any wetland site in the territory. This was mainly due to the relative ease of monitoring adult dragonflies by field observations, compared with collecting and identifying exuviae. However, as noted by Moore & Corbet (1990), the best method for monitoring odonate populations, particularly Anisoptera, at a specific wetland is to undertake regular counts of exuviae, and such counts should ideally be conducted daily, or failing this at a minimum of once per week throughout the emergence period. This is because exuviae provide irrefutable proof of successful breeding, and exuviae counts give a measure of the dragonfly production of particular wetlands.

Corbet & Hoess (1998) commented on the desirability of undertaking standardised exuviae collections, noting that exuviae normally remain on emergence supports for several days and, especially in Anisoptera, are conspicuous and readily identifiable to species, that counts of exuviae give a clearer picture of real dragonfly abundance than do male-biased counts of adults, and that numbers emerging from a small or medium-sized water body can usually be monitored by a single researcher.

In 2004 - 2005, the author had the opportunity to conduct a systematic study of dragonfly emergence at a small pond near Kam Tin, which had been created in late 2003, on land owned by the Kowloon-Canton Railway Corporation (KCRC).

Methods

Study site

The study pond, approximately 0.02ha, was excavated during 2003 (and completed by autumn of that year) at a site near Ho Pui, Kam Tin, New Territories (22°24'52" N, 114º04'13" E). Rushes (*Juncus*) and sedges (*Cyperus*) were established along the eastern and northern margins; while the western and southern margins held stands of emergent grass (*Panicum*), and a short stretch of reed (*Phragmites*). The pond was muddy-bottomed and sloped gently to a maximum depth of ca. 1.2m. No submerged or floating macrophytes were present. (Plate 1.)

Plate 1. The study pond

Exuviae surveys

Between the commencement of the study on 19 March 2004, and its cessation on 18 July 2005, 97 surveys of dragonfly exuviae were conducted at the study pond (following 18 July 2005, intermittent surveys were conducted until September 2005, but no further exuviae were observed). On each survey, the entire pond margin was searched, in a slow anti-clockwise walk. All anisopteran exuviae attached to the marginal vegetation or floating on the water surface were collected. Exuviae were subsequently identified with the aid of a dissecting microscope, using keys and illustrations provided by Zhou (1994), supplemented by various Japanese texts (Kawai, 1985; Ishida, 1996; Sugimura et al., 1991). Confirmation of exuviae identifications was occasionally made by association with teneral adults, either when the latter had failed to completely emerge from the exuviae, or when they were found perching in a deformed condition, and incapable of flight, beside their exuviae.

Survey frequency and persistence of exuviae in the field

Surveys were conducted on average more frequently than once per week, apart from the period 28 February to 28 March 2005, during which period the study was unfortunately suspended. From 19 March to 19 December 2004, mean interval between surveys was 4.5 days. From 3 January to 28 February 2005 it was 4.7 days, and from 28 March to 18 July 2005 it was 6.2 days.

Between March and June 2004, a total of 45 exuviae in the study pond were tagged (a length of red nylon string tied immediately below the exuviae on its emergence support, with date and species labelled), when known to be no more than three days (usually only one day) old. These tagged exuviae were not collected, and a note was made of the date on which they were found to be absent, in order to obtain an estimate of the mean length of time that exuviae remained in situ before being dislodged into the water or carried away by wind.

Results

Species present

Twelve species of Anisoptera were recorded as exuviae in the study pond between March 2004 and July 2005. These included two species of Aeshnidae, two of Gomphidae, one of Corduliidae and seven of Libellulidae (Table 1). A total of 646 exuviae was recorded over the 16 month study period. The most abundant species was the libellulid *Tramea virginia* (Rambur, 1842), of which 261 exuviae were collected, representing more than 40% of all exuviae. *T. virginia* exuviae were 2.5x more abundant than exuviae of the second and third most abundant species, *Anax guttatus* (Burmeister, 1839) and *Orthetrum sabina* (Drury, 1770). Exuviae were six times less abundant in 2005 than in 2004, and represented only three species.

Temporal trends in overall dragonfly emergence

A total of 180 exuviae, of five species, was recorded on the first survey date (19 March 2004). This was the highest total recorded on any survey date, and strongly indicates that dragonfly emergence was well under way by mid-March 2004. Numbers of exuviae declined in the ensuing months, with exceptions in June and August, when appreciable numbers of *A. guttatus* and *Sinictinogomphus clavatus* (Fabricius, 1775), respectively, were present. No exuviae were observed from 8 September 2004 to 28 February 2005. After 28 February 2005, surveys were suspended for four weeks. Upon their resumption on 28 March 2005, a single exuviae was recorded. Numbers rose appreciably in April 2005, mainly comprising *S. clavatus*, before declining in May. No exuviae were observed after May 2005. The overall dragonfly emergence from March 2004 to July 2005 is indicated in Figure 1.

Species emergence

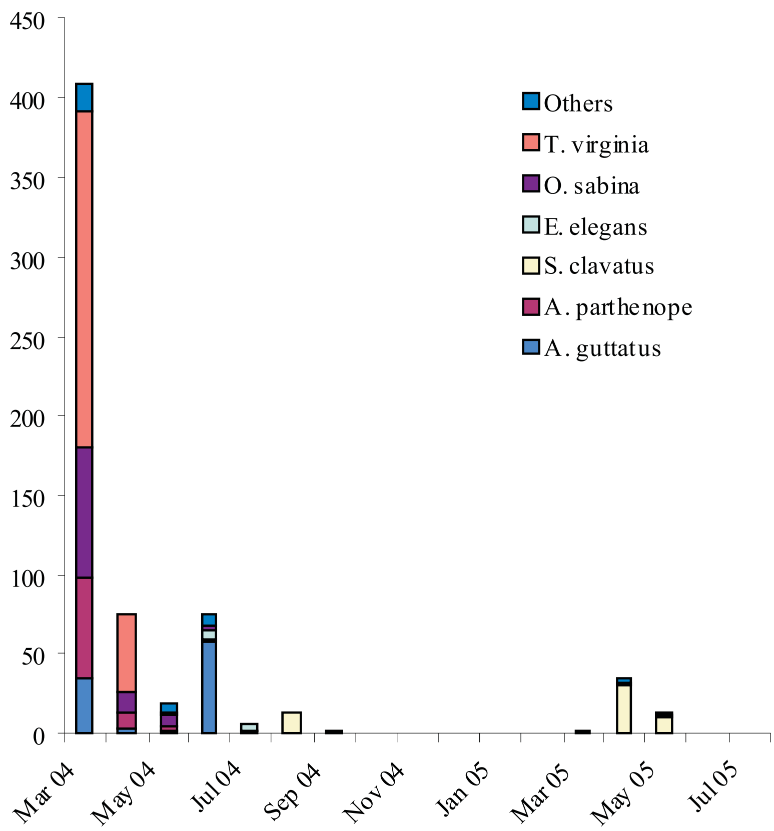
Aeshnidae

The large aeshnid *A. guttatus* was the third most abundant species recorded during the study (99 exuviae in total). The species had two obvious emergence pulses in 2004, with 40 exuviae collected between 19 March and 14 April, and 56 during the month of June (accounting for 77% of all exuviae collected in that month). Two exuviae were collected in May, and a single exuviae collected on 2 July. No further exuviae were found in 2004, and none at all in 2005 (Figure 1; Plate 2). Another large aeshnid, *Anax parthenope* (Brauer, 1865) was the fourth most abundant species, with 76 exuviae. As with its congener, *A. guttatus*, this species emerged in large numbers from mid-March to mid-April (71 exuviae), and was not observed after June 2004; however, unlike *A. guttatus*, there was no second emergence pulse in June, with only two exuviae recorded in that month (Figure 1).

Table 1. Dragonfly exuviae species and abundance in the study pond, 2004–2005

Species	Abundance 2004	Abundance 2005
Anax guttatus	99 (16.6%)	
Anax parthenope	76 (12.7%)	
Ictinogomphus pertinax	2 (0.3%)	4 (8.2%)
Sinictinogomphus clavatus	15 (2.5%)	43 (87.7%)
Epophthalmia elegans	10 (1.7%)	
Brachythemis contaminate	1 (0.2%)	
Crocothemis servilia	2 (0.3%)	
Diplacodes trivialis	15 (2.5%)	
Orthetrum sabina	105 (17.6%)	2 (4.1%)
Pantala flavescens	10 (1.7%)	
Tramea virginia	261 (43.7%)	
Trithemis aurora	1 (0.2%)	
Total	**597 (100%)**	**49 (100%)**

Figure 1. Abundance of dragonfly exuviae collected from the study pond



Gomphidae

Two exuviae of the large gomphid *Ictinogomphus pertinax* (Hagen in Selys, 1854) were collected in early June 2004, three in April 2005, and one in May 2005. *Sinictinogomphus clavatus* was quite scarce in 2004 (15 exuviae, recorded between 31 July and 5 September), but this large species accounted for 87.8% of all exuviae recorded in 2005 (43 exuviae, 31 of which were collected in April, and 11 in May). In August and September 2004, this was the only species which emerged from the study pond (Figure 1; Plate 3).


Plate 2. *Anax guttatus* (Aeshnidae)


Plate 3. *Sinictinogomphus clavatus* (Gomphidae)

Corduliidae

Ten exuviae of the very large pond corduliid *Epophthalmia elegans* (Brauer, 1865) were recorded during the study; all in the period 20 June to 26 July 2004 (Figure 1; Plate 4).


Plate 4. *Epophthalmia elegans* (Corduliidae)

Libellulidae

Tramea virginia was the most abundant species recorded in the study, although not seen after 18 May 2004. A total of 71 exuviae of this fairly large libellulid were collected on 19 March 2004, a further 108 five days later on 24 March, and 32 more on 27 March, amounting to 211 exuviae in the first eight days of the study. Numbers declined considerably in April (48 exuviae) and May (two exuviae). (Figure 1). *Orthetrum sabina* was the second most abundant species recorded in the study, and was present in both 2004 and 2005. In 2004, abundance was highest in March (82 exuviae) and steadily declined through April (13 exuviae), May (seven exuviae) and June (three exuviae). The species was not recorded again until 2005; single exuviae being collected in April and May of that year (Figure 1; Plate 5). Ten exuviae of *Pantala flavescens* (Fabricius, 1798) were collected in 2004; five in May and five in June. Thereafter, exuviae of this ubiquitous species were not observed. Only a single exuviae of the common pond libellulid *Brachythemis contaminata* (Fabricius, 1793) was recorded, on 24 March 2004, and only two exuviae of *Crocothemis servilia* (Drury, 1770), also in March 2004. In the same month, fifteen exuviae of the small libellulid Diplacodes trivialis (Rambur, 1842) were recorded, and none thereafter. A single exuviae of *Trithemis aurora* (Burmeister, 1839) was collected on 6 May 2004.


Plate 5. *Orthetrum sabina* (Libellulidae)

Persistence of exuviae in the field

Mean persistence of anisopteran exuviae in the field was estimated as 3.4 days (n = 45 exuviae, from five species). The shortest duration was one day (12 exuviae, from four species). One *A. guttatus* exuviae remained in situ for at least 31 days after tagging.

Discussion

It is unfortunate that the study did not commence earlier in 2004, as it would be useful to know which, if any, species emerged from the pond as temperatures began to rise in late February / early March 2004. Surveys by the author at numerous ponds over subsequent years (as yet unpublished other than in 'grey' literature) indicate that pond-dwelling dragonflies typically start to emerge in this period. As it was, the start of the study coincided with a mass emergence by several species, which rapidly dwindled, such that by the end of March, at least 68.5% of all of the study pond's dragonfly production in 2004 had been completed (and 81% by the end of April). All of this dragonfly emergence must have derived from oviposition in mid to late 2003. Similarly, the larger gomphid and corduliid dragonflies which began to emerge from June 2004 must have come from eggs laid in 2003: *I. pertinax*, *S. clavatus* and *E. elegans* would all require longer than six months for larval development. The libellulid *P. flavescens* is, however, known to have a short larval development time of about 50 days (Corbet, 1999, p. 227), and it is likely that the ten individuals of this species which emerged in May-June 2004 were from eggs deposited earlier in the year.

It is interesting to compare the emergence patterns for the two *Anax* species in 2004. *A. parthenope* followed the same pattern as exhibited by the seven libellulidae species, with peak emergence in March, followed by a rapid decline in abundance. Its congener *A. guttatus*, however, although quite abundant in March (and declining in April and May), showed an abrupt emergence peak in June. All of the emerging species have a Hong Kong flying and breeding season which extends well into November (Wilson, 2004), and indeed December in many cases, and it is therefore curious that so much of the 2004 emergence in the study pond was concentrated in March – one might expect emergence to be more equably distributed across the warm humid months from March to September.

Even more unexpected was the collapse in dragonfly emergence in 2005, with *S. clavatus* the only species emerging in moderate numbers. Considerable breeding activity was observed among adult dragonflies at the study pond throughout 2004, yet very few larvae emerged in the following year. Perhaps cool weather in early 2005 effectively suppressed dragonfly emergence in that year? Minimum daily temperatures across the North West New Territories dropped below 10ºC for several days in the last week of February 2005, but did not fall below 16ºC in the corresponding period in 2004. Average daily minimum temperatures throughout March 2005 were 3ºC lower than in March 2004. Nevertheless, temperatures in early 2005 were not exceptionally low for Hong Kong. More likely, predatory fish in the pond were too small and too few to impact dragonfly larvae significantly in early 2004, but had become a major threat to larval dragonflies by mid-2004. These fish were introduced as eggs or fry when the pond was initially filled in 2003, with water piped from Ho Pui reservoir. They were more evident in 2005, and would undoubtedly have had a predation impact on dragonfly larvae, particularly smaller ones such as libellulids and early instar aeshnids.

It is worth mentioning that the frequency of exuviae surveys in the present study would not have been sufficient to ensure that all dragonfly emergence from the pond was recorded: in order to achieve such an outcome, daily surveys would be necessary. This was not practicable, but from the tagged exuviae results it seems likely that a survey frequency of every three days would give a very close estimate of total emergence.

It is notable that only 12 species of Anisoptera emerged from the study pond during the period March 2004 to July 2005. Over the same period, the author recorded more than 25 species as adults at the pond (AEC, 2006). This suggests that many dragonflies immigrated to the pond as adults, without having bred there. Monitoring adult dragonflies at a given wetland can therefore give a misleading assessment of its value as a dragonfly breeding site – not all the species observed as adults will successfully breed.

References

AEC, 2006. *KCRC West Rail Contract No. TSA-024, Ecological Monitoring for West Rail. Summary Report, 2004 - 2005.* Asia Ecological Consultants, Hong Kong. [Report submitted to KCRC.]

Corbet, P.S. & R. Hoess, 1998. Sex ratio of Odonata at emergence. *International Journal of Odonatology* 1(2): 99-118.

Ishida, K., 1996. *Monograph of Odonata Larvae in Japan*, Hokkaido University Press, Sapporo.

Kawai, T. (Ed.), 1985. *An Illustrated Book of Aquatic Insects of Japan*, Tokai University Press.

Moore, N.W. & P. S. Corbet, 1990. Guidelines for monitoring dragonfly populations. *Journal of the British Dragonfly Society* 6(2): 21-23.

Sugimura, M., S. Ishida, K. Kojima, K. Ishida, & T. Aoki, 2001. *Dragonflies of the Japanese Archipelago in Color*. Sapporo, Hokkaido University Press.

Wilson, K.D.P., 2004. *Field Guide to the Dragonflies of Hong Kong*. Cosmos Books Ltd., Hong Kong.

Zhao, X., 1994. Odonata. In *Aquatic Insects of China useful for Monitoring Water Quality*. Hohai University Press, Nanjing, pp. 135-175.

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