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Upright emergence in *Petalura gigantea* (Odonata: Petaluridae)

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Abstract

During the 2003/2004 summer flying season, upright emergence of a male *Petalura gigantea* was observed and photographed in the Blue Mountains of New South Wales during an extensive survey for the species. This observation differed from the only previous illustration of a hanging back emergence style, and is compared with observations of emergence style for the other Petaluridae. While the earliest accounts illustrated or suggested a hanging back emergence style in *P. gigantea*, *Uropetala chiltoni* and *Tanypteryx hageni*, upright emergence has subsequently been documented in *T. pryeri*, *U. carovei* and *Tachopteryx thoreyi*. The observation of upright emergence in *P. gigantea* reported in this paper further suggests that upright emergence may be the norm for all petalurids. However, additional observations will be necessary to resolve the question of emergence style within the Petaluridae.

Introduction

In an evolutionary context the Petaluridae are generally considered the most primitive of the Anisoptera (Silsby 2001). The extant Petaluridae consist of five genera with up to 11 species currently recognised worldwide. They include the endemic Australian genus *Petalura* with five species, *Uropetala* with two species – *U. carovei* (White) and *U. chiltoni* Tillyard – in New Zealand, the monotypic *Phenes raptor* Rambur in Chile, *Tanypteryx* with one species – *T. hageni* (Selys) – in western North America and one species – *T. pryeri* (Selys) – in Japan, and the monotypic *Tachopteryx thoreyi* (Hagen) in eastern North America. The genus *Petalura* includes *P. gigantea* Leach (New South Wales), *P. hesperia* Watson (W Australia), *P. ingentissima* Tillyard (N Queensland), *P. litorea* Theischinger (SE Queensland, NE New South Wales) and *P. pulcherrima* Tillyard (N Queensland) (Hawking & Theischinger 2004). The status of *P. pulcherrima* as a distinct species however remains uncertain (Davies 1998; Hawking & Theischinger 2004).

Emergence has previously been illustrated or described in whole or part for *P. gigantea* (Tillyard 1917), *T. pryeri* (Eda 1959), *T. hageni* (Svihla 1960a), *T. thoreyi* (Dunkle 1981) and *U. carovei* (Winstanley et al. 1981). The authors are not

aware of any published observations of emergence in *P. raptor*, although Svihla (1960b) reported that an exuvia had been found clinging to the bark of a tree several feet above the ground. No observations have been documented for the remaining species of *Petalura* in Australia.

Eda (1959: 18) identified two distinct emergence types in the Odonata, the upright and hanging back postures. The upright type described by Eda includes the gomphoid (0-90°) and agrionoid (70-120°) groups, with the hanging back type (90-180°) the remainder. After the head and thorax have been withdrawn from the exuvia, during the resting phase the upright type is characterised by the head and thorax being held more or less parallel with the exuvia and the legs held back towards the thorax. "Within a single species there can be much individual variation, though seldom beyond the limits for the type defined by Eda" according to Corbet (1962: 102); who continued, stating that "certain members of the hanging type, such as Petaluridae, Aeshnidae and deep-burrowing Gomphidae, seem to require an inclination of at least 90°, thus often adopting a position in which the dorsal surface of the larva faces downwards." Commenting on this, F. Suhling (pers. comm.) has indicated that in his experience with deep burrowing gomphids (*Phyllogomphus*, *Neurogomphus*, *Mastigogomphus*), and while their emergence is the same as the normal gomphid style, they are more likely to be found in a 90° position than other gomphids. Corbet (1999: 240) later provided a synopsis of representative taxa for the two emergence postures, stating that in addition to the Zygoptera and Gomphidae; *T. pryeri*, *T. hageni*, *T. thoreyi* and *U. carovei* all utilise the upright posture, with *P. gigantea* utilising the hanging back posture. In respect of Tillyard's illustration of a hanging back emergence style in *P. gigantea*, Corbet (1999: 240) commented that "confirmation of this observation would now be appropriate." Silsby (2001: 145) subsequently stated that petalurid emergence is of the upright type utilised by zygopterans and gomphids, and not the hanging back type of the remaining anisopterans.

Previous observations of emergence in the Petaluridae

The only documented record for an observation of emergence in any species of the genus *Petalura*, and the first for any petalurid, is for *P. gigantea* (Tillyard 1917). Previous detailed descriptions of the natural history of this species by Tillyard (1909, 1911), from observations in swamps in Leura and Medlow Bath in the Blue Mountains, did not include any mention of an observation of emergence. Tillyard (1917: 94-95) subsequently provided a series of illustrations depicting emergence in *P. gigantea* that clearly showed the species utilising a full hanging back emergence posture during the resting phase, but did not indicate where or when the observation was made. This illustration depicted emergence on a vertical support, with the partly emerged teneral arched backwards with the head pointed towards the ground.

In his detailed life history study of the species, Wolfe (1953) did not report any specific observations of emergence style for *Uropetala chiltoni* from the South Island of New Zealand, other than to state that emergence "did not differ from *Petalura*", thus by default suggesting a hanging back emergence style for *Uropetala*.

The observation of emergence in *Tanypteryx pryeri* described and photographed by Eda (1959), from a population of the species west of Tokyo, clearly depicts an upright emergence style during the resting phase. After withdrawing its legs the teneral released its hold on the exuvia and rested back slightly into a step type posture with the head upright and upper abdominal segments held more or less at right angles (horizontal) to the vertically perched exuvia. This 'recess' lasted for about half an hour, which according to Eda was unusual for the upright emergence type. This type is usually characterised by a resting phase lasting only 5-10 min, in contrast usually to a period of 20-30 min for the hanging type according to Eda. Eda noted the comparison between his observation of upright emergence in *T. pryeri* and Tillyard's illustration of a hanging back style in *P. gigantea*.

Svihla (1960a) subsequently described emergence and transformation in *T. hageni* from Mount Rainier National Park in Washington and stated that in relation to the previous accounts of emergence for *P. gigantea* (Tillyard 1917) and *U. chiltoni* (Wolfe 1953), "These acts are essentially the same in *T. hageni* but there are a few differences." Svihla described these differences in transformation in relation to the expansion of the wings and abdomen and the development of colour pattern, but in regard to emergence style, simply commented that the head and thorax bent over backwards with the abdomen still in the case. Although there is no other detail in relation to emergence style in this account by Svihla, the description would appear to also suggest a hanging back emergence style. However, such a suggestion is inconsistent with the synopsis of Corbet (1999: 240), which (citing Svihla 1960a) lists *T. hageni* as a species with an upright emergence style. The duration of this resting phase was much shorter than that observed by Eda for *T. pryeri*, with Svihla (1960a) noting that at 12:20 h the individual bent over backwards and at 12:25 h, almost fully out of the exuvia, the legs grasped onto *Carex* leaves.

Figure 1: Emergence of *Petalura gigantea* — upright emergence posture during the resting phase. Blue Mountains of New South Wales, 15 December 2003. Photo by Chris Ireland.

Dunkle (1981: 192) provided a partial description of emergence and transformation for *Tachopteryx thoreyi* from a population in Florida, but noted that the entire emergence sequence was not observed. However, he observed that "Transformation occurs on vertical stems of any size from herb stems to tree trunks, and the emergence is similar to that in the Gomphidae and in *T. pryeri* (Eda 1959). The emerging adult supports itself upright on the abdomen with the legs held close to the thorax." This description confirms an upright emergence style for *T. thoreyi*.

While Winstanley (1981: 29) did not observe emergence, he reported that all exuviae of *U. carovei* observed in a study of the species on the North Island of New Zealand were oriented vertically upon their emergence supports regardless of the orientation of the support. Winstanley et al. (1981) subsequently provided a clear description of upright emergence in *U. carovei* from the North Island, stating that "The head, thorax and legs were withdrawn within 12 min, then the upright resting attitude was assumed and maintained for 44 min."

Recent observation of upright emergence in *Petalura gigantea*

During what appears to have been a significant emergence event for *P. gigantea* in the Blue Mountains of New South Wales during the 2003/2004 summer flying season, full emergence was observed in the field on 15 December 2003 and photographed at frequent and regular intervals. This appears to be the first documented observation of emergence for the species since Tillyard (1917), and occurred at ca 1,000 m alt. in a swamp in Medlow Bath where it is most likely that Tillyard (1911) made his detailed study of a *P. gigantea* burrow complex. The swamp vegetation is characteristic of Blue Mountains Sedge Swamp of Keith & Benson (1988). The male larva was observed at 06:04 h (solar time) beginning to ascend a cluster of stems of Buttongrass *Gymnoschoenus sphaerocephalus* (Cyperaceae) and commenced ecdysis at 06:49 h, with the larva perched vertically ca 40 cm above ground level. At 07:06 h the legs were released from the exuvia, with the individual leaning back slightly into the position that it maintained throughout the resting phase. During this period, the head and thorax were held upright, while the remaining exposed upper abdominal segments were held out more or less horizontally from the vertically perched exuvia in a step shaped posture, with the legs held back towards the thorax (Fig. 1). The individual then re-grasped the exuvia with its legs at 07:35 h and continued withdrawing its abdomen to complete emergence at 07:39 h, a total of 50 min to complete emergence. In total the individual spent 29 min with its legs released from the exuvia and held back towards the thorax throughout the resting phase. By 08:07 h the wings were expanded to the extent that they were longer than the abdomen and by 09:49 h the rich imaginal colour was obvious. The teneral remained perched upon the exuvia at 10:24 h when observation was discontinued. The weather was cloudy with early intermittent mist and increasing patchy sun after rain the night before.

This observation of emergence was the only one during extensive field survey for the species during both the 2003/2004 and 2004/2005 summer flying seasons in the Blue Mountains. During this period, numerous tenerals were observed in various degrees of transformation post emergence, still perched upon or closely associated with their exuvia, at various times of the day.

Discussion

Comparing the earlier accounts by Tillyard (1917), Wolfe (1953) and Svihla (1960a) with the more recent observations of upright emergence in *Tanypteryx pryeri* (Eda 1959) and the then unpublished observation of upright emergence in *Tachopteryx thoreyi* (S.W. Dunkle pers. comm., cited in Winstanley 1981), Winstanley (1981) stated that "It is otherwise unknown for species in the same genus, or for those in the same family, to have such radically different emergence behaviours and I share with Professor Eda and S.W. Dunkle (pers. comm.) the view that emergence in *P. gigantea*, *T. hageni* and *U. carovei* warrants re-examination." Eda (1963, 1964, cited in Winstanley et al. 1981), Winstanley (1981) and Winstanley et al. (1981) noted the anomaly of previous accounts or suggestions of a hanging back emergence style for *Petalura gigantea* (Tillyard 1917), *Uropetala chiltoni* (Wolfe 1953) and *T. hageni* (Svihla 1960a), a point also taken up indirectly by Corbet (1999: 240) in respect of *P. gigantea*. Having subsequently confirmed upright emergence in *U. carovei*, Winstanley et al. (1981) stated that "this reinforces the suggestion (Winstanley 1981) that emergence behaviour in *P. gigantea* and *T. hageni* should be re-investigated."

The upright resting position and duration of the resting period described in the current paper for *P. gigantea*, closely matches that of *T. pryeri*, described by Eda (1959). Although Eda (1959) and Corbet (1999: 240) stated that the duration of the resting period for the upright emergence type was usually 5-10 min, it is interesting to note that the observed resting periods for *T. pryeri*, *U. carovei* and *P. gigantea* ranged from 29-44 min. With this observation of upright emergence in *P. gigantea*, and with respect of the above suggestion by Winstanley (1981) and Winstanley et al. (1981), the emergence style in *T. hageni* still requires clarification.

In an evolutionary context, F. Suhling (pers. comm.) has suggested the possibility that in view of the phylogenetic placement of the Petaluridae at the base of the Anisoptera, both emergence styles may be present within the Petaluridae and that a high level of variability in emergence style within a single species should not be discounted without further evidence. This possibility may explain the inconsistency between Tillyard's description of hanging back emergence in *P. gigantea* and the observation of upright emergence described in this paper.

Conclusion

The above observation of upright emergence in *Petalura gigantea* is inconsistent with the hanging back style illustrated by Tillyard (1917), but is consistent with the well-documented descriptions of an upright emergence style in *Tanypteryx pryeri* (Eda 1959), *Tachopteryx thoreyi* (Dunkle 1981) and *Uropetala carovei* (Winstanley et al. 1981). This observation of upright emergence in *P. gigantea* further suggests that upright emergence may be the norm in the Petaluridae. However, in view of the generally singular observations of emergence for those species described above and the lack of any documented observations for the remaining petalurid species, the possibility remains that there may be a high level of variability in emergence style either within or between species in the Petaluridae. Further observations of emergence will be necessary to finally resolve this question.

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