15 The life histories of three tropical species of *Jappa* Harker (Ephemeroptera: Leptophlebiidae) in the Mitchell River system, Queensland, Australia

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The life histories of three species of Jappa, J. serrata, J. edmundsi *and an unnamed species, were documented in the Mitchell River system in far north Queensland. All three species appeared to have asynchronous, aseasonal multivoltine life histories.* Jappa *sp., the smallest of the species, was the only* Jappa *species collected in the Mitchell River, and appeared to complete its life cycle in 75-120 days or 2000-3000 degree days.* Jappa serrata *and* J. edmundsi *occurred together in Luster Creek.* Jappa serrata *had a life cycle of about 130 days or 3500 degree days, while* J. edmundsi, *for which conclusions are tentative, was somewhat faster at 100 days or 2500 degree days.* Jappa edmundsi *appears to undergo a habitat change during its life cycle, and the habitat of the small instars is as yet unknown.*

Introduction

Although there have been a number of recent studies of the life histories of temperate Australian mayflies (e.g., Suter and Bishop 1980; Campbell and Holt 1984; Campbell 1986; Campbell et al. 1990), the life histories of only two species of tropical Australian mayflies have been published (Marchant 1982). This paucity of information partly reflects the relatively small number of stream ecologists living in tropical Australia, and partly the difficulty of interpretation of size frequency data for species that lack distinctly seasonal and synchronous life histories (*sensu* Lake et al. 1985). For the same two reasons there are also fewer accounts of the life histories of tropical, compared with temperate, mayflies in the international literature. Clifford (1982), in an extensive review, cited only 18 studies of the life histories and/or biology of tropical mayflies, of which five dealt with the species *Povilla adusta* and two with *Dolania americana*. Few additional studies have been published since.

Jappa Harker is a genus of the Leptophlebiidae (Atalophlebiinae) restricted to Australia. It includes four described species, two of which, *Jappa serrata* and *J. edmundsi*, occur in tropical north Queensland (Skedros and Polhemus 1986). There are also a number of undescribed species that belong to the genus (Campbell unpublished data). Nymphs of the genus are characterized by the presence of a pair of large projections ("horns") anteriorly on the head (e.g., see Campbell 1990; Peters and Campbell 1991). The nymphs usually live under rocks associated with sandy substrates in streams.

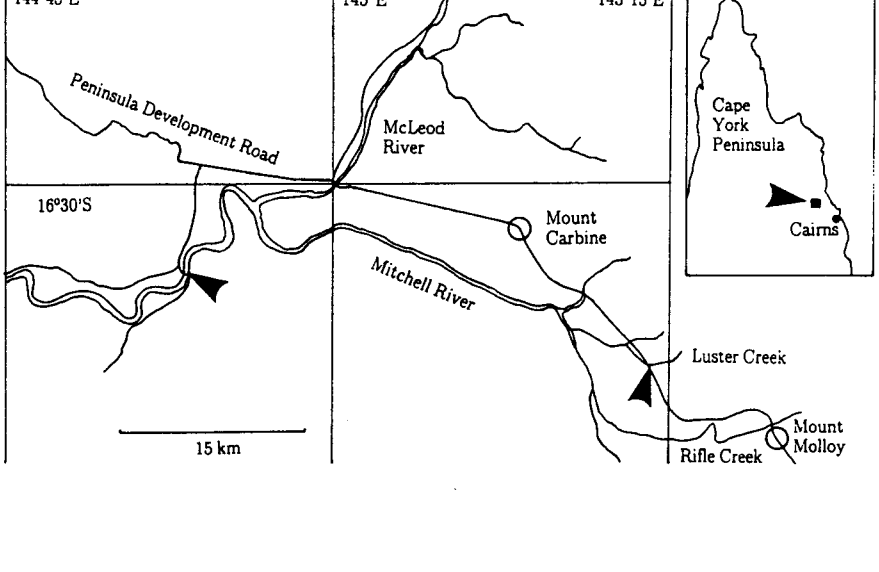
This study provides the first account of the life histories of three *Jappa* species, *J. serrata*, *J. edmundsi* and an undescribed species, referred to here as *Jappa* sp. The studies were carried out in the main stream and a tributary of the Mitchell River, an ungauged river system believed to have the second largest mean annual discharge of any Australian river (Brown 1983). The Mitchell system drains the western side of the Great Dividing Range between Cairns and Cooktown. Most of the water is derived from the headwater areas, which are densely vegetated with tropical rainforest. The majority of the catchment consists of open eucalypt woodland with a median annual runoff between 800 and 1200 $mm \cdot y^{-1}$.

Materials and Methods

Sampling was carried out in the Mitchell River at a site known locally as Cooktown Crossing (although it is no longer on the Cooktown Road) near Hurricane Station (Fig. 1). At this site the river is order seven and approximately 30 m wide with a largely sand bed, but immediately upstream of the concrete culvert there is an extensive area of stones on sand in virtually standing water. Luster Creek is a second order tributary of the Mitchell flowing from Mount Fraser. At the sampling site, immediately upstream of the Northern Development Road, the stream formed a 50 m long pool, about three m wide. The substrate sampled consisted of flat rocks on sand and silt, but the pool contained extensive drifts of terrestrial litter. At both sites water temperature was recorded to the nearest 1°C using a maximum-minimum thermometer.

The mayfly populations were sampled at intervals of between two and four weeks from September 1987 to July 1988. On each occasion rocks were carefully lifted from the stream bed and a 300 μm mesh net placed under them. The rocks were then lifted from the stream and the nymphs washed from them into a sorting tray. The water was almost always clear, so that any nymphs which swam from the rocks and avoided the net during the removal process would have been clearly visible. The contents of the sorting tray were poured through a 300 μm net and preserved in Kahle's solution. In the laboratory, the nymphs were picked from the debris. Head width and the length from the anterior margin of the pronotum to the posterior margin of the mesonotum (which in larger nymphs was the hind margin

Figure 1. The location of the study sites.



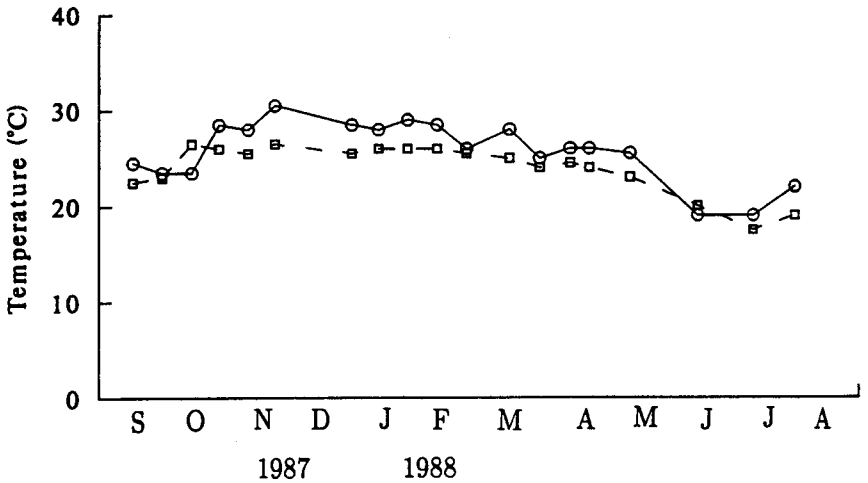
of the wing buds) were measured to the nearest 0.1 mm. Size frequency data were plotted in 0.2 mm size classes, and changes in size classes interpreted by eye. On most sampling occasions light trapping was also conducted at the Mitchell River site.

Results

Stream temperatures (Fig. 2) were generally high. The Mitchell River ranged from 18°C in June and October to 33°C in November, with an annual total of accumulated degree days of about 9300°d·y^{-1}. Luster Creek was slightly cooler ranging from 17°C in July to 29°C in November, accumulating about 8500°d·y^{-1}.

Jappa sp. was the only Jappa species collected at the Mitchell River site. It was the smallest of the three species and was characterized in the nymph by unserrated horns. Large nymphs were collected throughout the year with the exception of the period from January to early February (Fig. 3). Adults were collected at the light during that period, indicating that larger nymphs were scarce but not absent during

Figure 2. **Mean water temperatures ((maximum + minimum)/2) at the Mitchell River site (solid line with circles) and Luster Creek site (dashed line with squares) during the study period.**



that period. In the fortnight prior to 10 February 1988, heavy rain in the catchment close to the site (a relatively unusual occurrence) caused the deposition of a 20 cm layer of sand over the sampling area, eliminating most of the population. At the subsequent sampling time the sand had been flushed away and a large cohort of small nymphs was evident, presumably resulting from recruitment to the population. This cohort could be tracked through until it emerged between early May and mid-June. This gives a life cycle of about 75-120 days or about 2000-3050 degree days.

Jappa serrata and *J. edmundsi* are both larger species than *Jappa* sp., and the two occurred sympatrically at the Luster Creek site with nymphs of both species occurring together on the same rocks. *Jappa serrata* was the more abundant of the two. Again, both large and small nymphs were collected virtually throughout the year, although mature nymphs were relatively rare and noticeably smaller during the cooler months, June and July (Fig. 4). Several apparent, albeit ill-defined, cohorts occurred, all of which had an apparent life cycle of about 130 days or 3500 degree days. *Jappa edmundsi* was far less abundant in the samples than *J. serrata* (Fig. 5), and, as a result, the interpretations must be treated as speculative. Samples

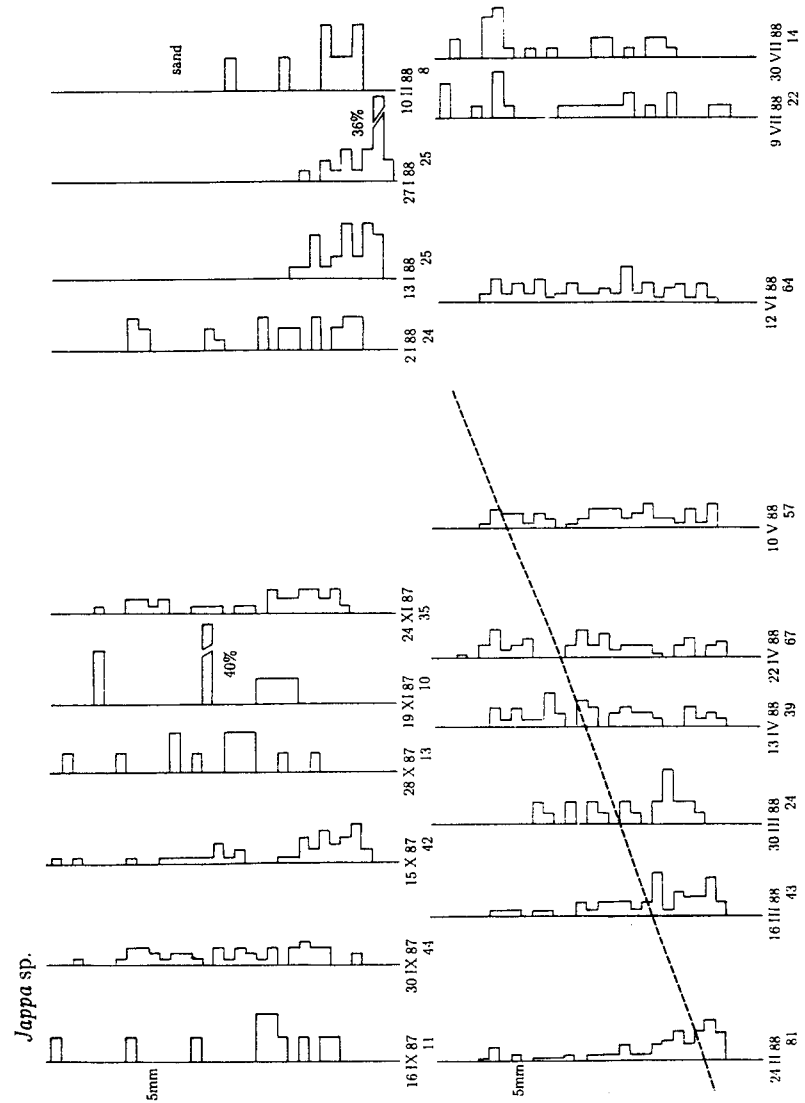
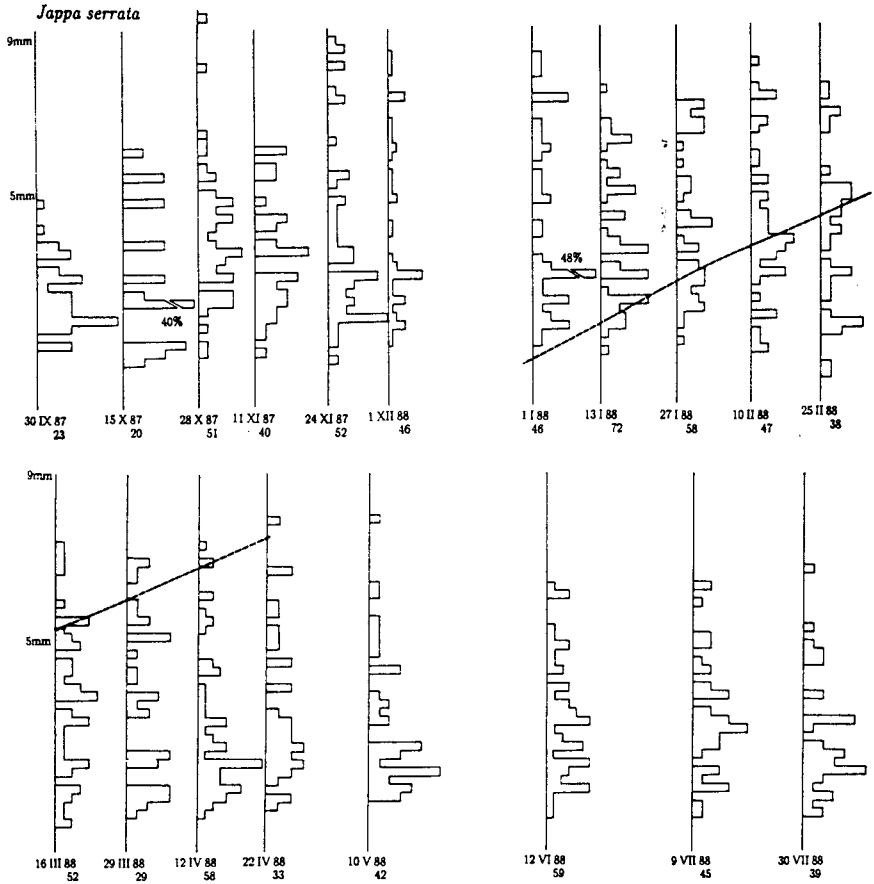


Figure 3. Size frequency histograms based on length of the pro- + mesonotum for *Jappa* sp. at the Mitchell River site. The distance between the base lines is proportional to the time interval between the samples. The date and number of nymphs collected is indicated below each histogram. The dashed line indicates a likely life cycle.

Figure 4. **Size frequency histograms for *Jappa serrata* at the Luster Creek site. Details as for Figure 3.**



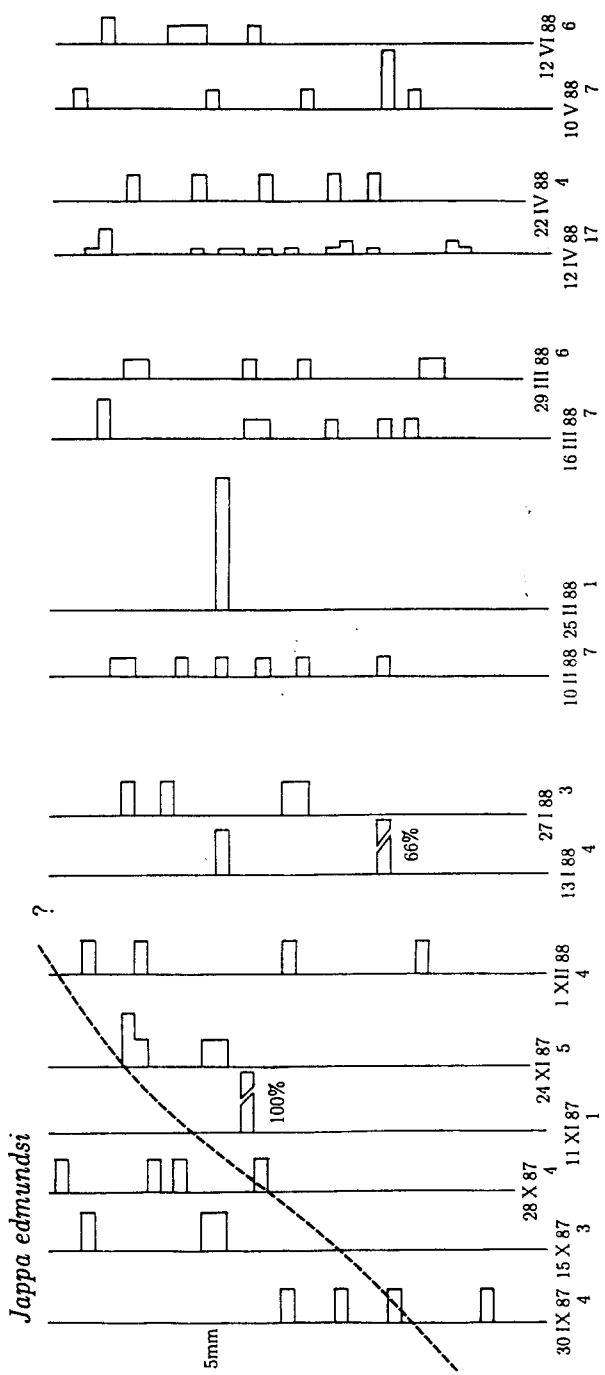


Figure 5. Size frequency histograms for *Jappa edmundsi* at the Luster Creek Site. Details as for Figure 3.

seemed to be biased towards large nymphs, which were present throughout the year. If the absence of small nymphs in October-November was real and not simply caused by sampling error, the life cycle appears to take about 100 days or about 2500 degree days.

Discussion

All three species investigated had aseasonal, asynchronous multivoltine life cycles, with emergence recruitment and growth throughout the year. Such life cycles are thought to be typical of tropical mayflies living in permanent waterbodies (Clifford 1982). Similar types of life cycles have been previously recorded for two mayfly species from the Magela Creek system in Arnhem Land (Marchant 1982). The trend towards aseasonal, asynchronous multivoltine life histories with decreasing latitude has also been noted in the North American fauna by Berner and Pescador (1988).

The life cycles reported here are comparable, in terms of the number of degree days required, with those of large Australian temperate Ephemeroptera. Campbell (1986) noted that most species occurring in streams that accumulated between 2500 and 3500°d·y^{-1} were univoltine. In the Mitchell system, *Jappa* sp., with the shortest life cycle, was the smallest species, having a maximum body length of about 15 mm compared with about 20 mm for the other two species. This, together with the higher water temperature in the Mitchell River, probably accounts for the shorter life cycle of the species.

The co-occurrence of *J. serrata* and *J. edmundsi* is intriguing. The two species are of similar size, and a cursory inspection of their gut contents indicated that both are detrital feeders, but the form of the horns on the two species is strikingly distinctive. In *J. serrata*, the horns are stouter with multiple serrations, while in *J. edmundsi* they are longer, more slender and bear a single spine (e.g., see Skedros and Polhemus 1986). The absence of significant numbers of small nymphs of *J. edmundsi* and the low abundance of larger nymphs suggest that this species spends much of its life in another habitat and either undergoes a habitat switch in the later instars or else a few large instar nymphs migrate into another habitat. However, repeated searches within the pool failed to reveal significant numbers of *J. edmundsi* nymphs in any other habitat. One possibility is that the sampling site is at the downstream end of the species range. It is also possible that the species is primarily hyporheic, since the stream is braided with significant stretches flowing through cobble beds. It would be of great interest (and relatively simple) to investigate interactions between the species. Cursory laboratory observations revealed apparently aggressive interactions between them with the horns being used as the main weapon.

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