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THE LIFE HISTORY OF KIRRARA PROCERA HARKER (EPHEMEROPTERA) IN TWO SOUTHEASTERN AUSTRALIAN RIVERS

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Abstract. Nymphs were taken monthly between July 1972 and January 1981 by "kick" sampling at localities of the Wellington and Goodradigbee Rivers. Their presumed growth is expressed by means of size frequency histograms using mesonotum length. Small nymphs were collected in February, mature ones appeared in November. Flight period may last to April. Delayed hatches /e.g. August 1979/ in later winter develop rapidly during summer months. This univoltine life cycle type differ markedly from those of the Australian siphlonurids and oligoneuriids, and South Australian leptophlebiids.

Nymphs, growth, habitats

The nymphs of *Kirrara procera* are comparatively common in lower altitude stony streams in Southeastern Australia. In spite of this, the rather unusual nymph has only recently been described (Campbell, in press), and the life history was unknown prior to the present study.

The collections on which this study were based were made by the senior author, in the course of studies on the life histories of siphlonurid and oligoneuriid mayflies. *Kirrara procera* was found to be abundant at two of the sites used in that study: the Goodradigbee River at Wee Jasper in southern New South Wales, and the Wellington River in Victoria (Fig. 1). Both rivers are about 20 m broad, quite shallow (<30 cm at base flow) and stony. They are comparatively warm, both rising above 20°C in summer and remaining above 5°C in winter (Fig. 2).

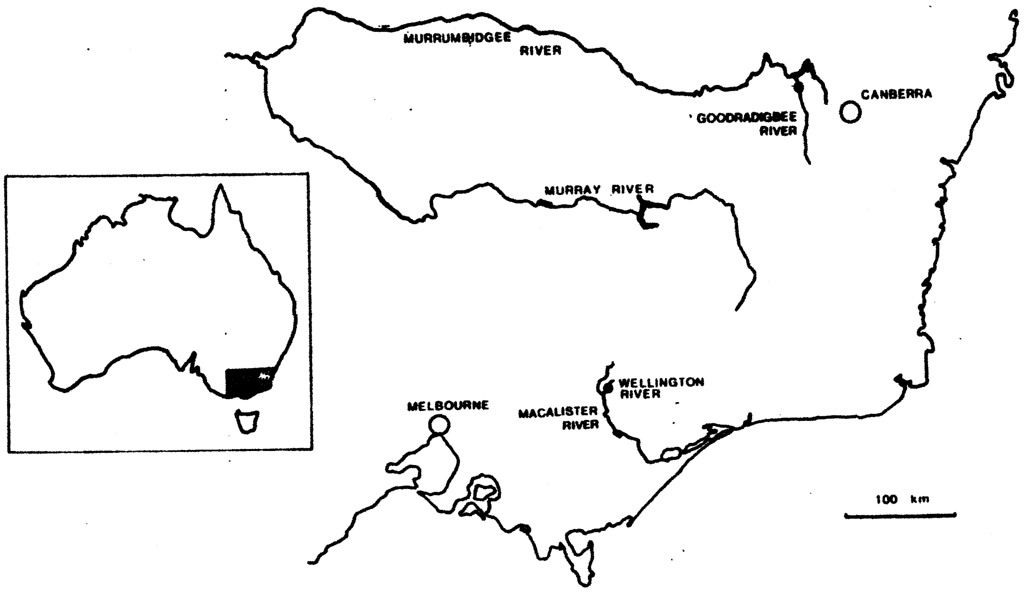

Fig. 1: A map of southeastern Australia indicating the sampling locations on the Wellington and Goodradigbee Rivers.

METHODS

Several collections of nymphs were taken at approximately monthly intervals between July 1977 and January 1981. Collections were taken by "kick" sampling (Macan 1958), using a rectangular framed FBA type net fitted with a nylon mesh with a pore size of 300 . Samples were preserved in the field using Kahle's solution (Norris and Upton 1974), and sorted on return to the laboratory using a Wild M7A stereomicroscope at approximately 10X magnification. Water temperature was determined on each sampling occasion using a mercury thermometer, and, during 1980, current speed was determined using a stopwatch and an orange attached to a 2 m long string.

To determine the life history, size frequency histograms were constructed using mesonotum length (including wing pad length) as the dimension plotted. Measurements were made to the nearest 0.05 mm using a Wild M7A stereomicroscope at 20X magnification, fitted with an eyepiece graticule.

The dimension chosen was somewhat unusual. Total length and headwidth have more commonly been used in mayfly life history studies (e.g. Brittain, 1976; Chaffee and Tartar, 1979; Clifford, 1970; Corkum, 1978; Marchant, 1982; Voschel, 1982). The reasons for selecting mesonotum length in preference to either of these dimensions will be discussed in more detail elsewhere (Campbell, in prep.); but, briefly, mesonotum length offers three advantages: the mesonotum is a rigid structure and is therefore not subject to "telescoping" problems as is total length. It is easy to measure and has a relatively larger change in size, which allows easier differentiation of size classes than does headwidth. Finally, the sudden rapid growth in wing pads in mature nymphs means that the presence of

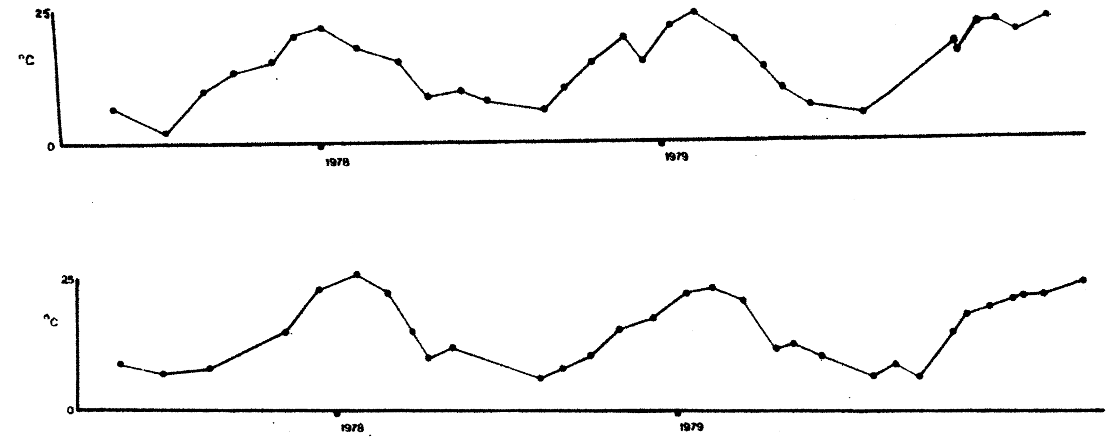

Fig. 2: Stream temperatures recorded from the Goodradigbee /top/ and Wellington /bottom/ Rivers during the course of the study.

mature nymphs is clear from the size frequency diagrams. This generally provides a good indication of the emergence period.

RESULTS

Results are presented as a series of size frequency histograms, spaced according to the time interval between collections (Fig. 3, 4). As an aid to interpretation the size frequency data was analysed using Cassie's (1954) technique to separate cohorts. This was particularly useful during the summer period. The mean size of each cohort determined by this method is indicated by a thick horizontal line overlaid on the size frequency histogram. The fine lines connecting the cohort means indicate presumed growth.

DISCUSSION

Similar life history patterns were evident in both the Wellington River and the Goodradigbee River populations. The sizes of the samples from the Wellington River were larger than those from the Goodradigbee, and probably give a clearer indication of the life history patterns.

Mature nymphs are present in the Wellington River population between November and April (Fig. 3). This would indicate a fairly long emergence period. Large numbers of small nymphs were collected in 1978 in March and April, and a little earlier the following year, indicating that many of the eggs hatch fairly rapidly. Growth of these hatchlings occurs fairly slowly through the winter, with the nymphs growing to maturity in the following summer. However, the continued collection of small nymphs through the winter, with perhaps a second peak of hatching in late winter (e.g. August 1979) or early summer (e.g. December 1977) probably indicates significant delayed hatching, which may be stimulated by some environmental factor or factors. Nymphs from these delayed hatches apparently develop rapidly during the summer period, emerging in late summer or autumn.

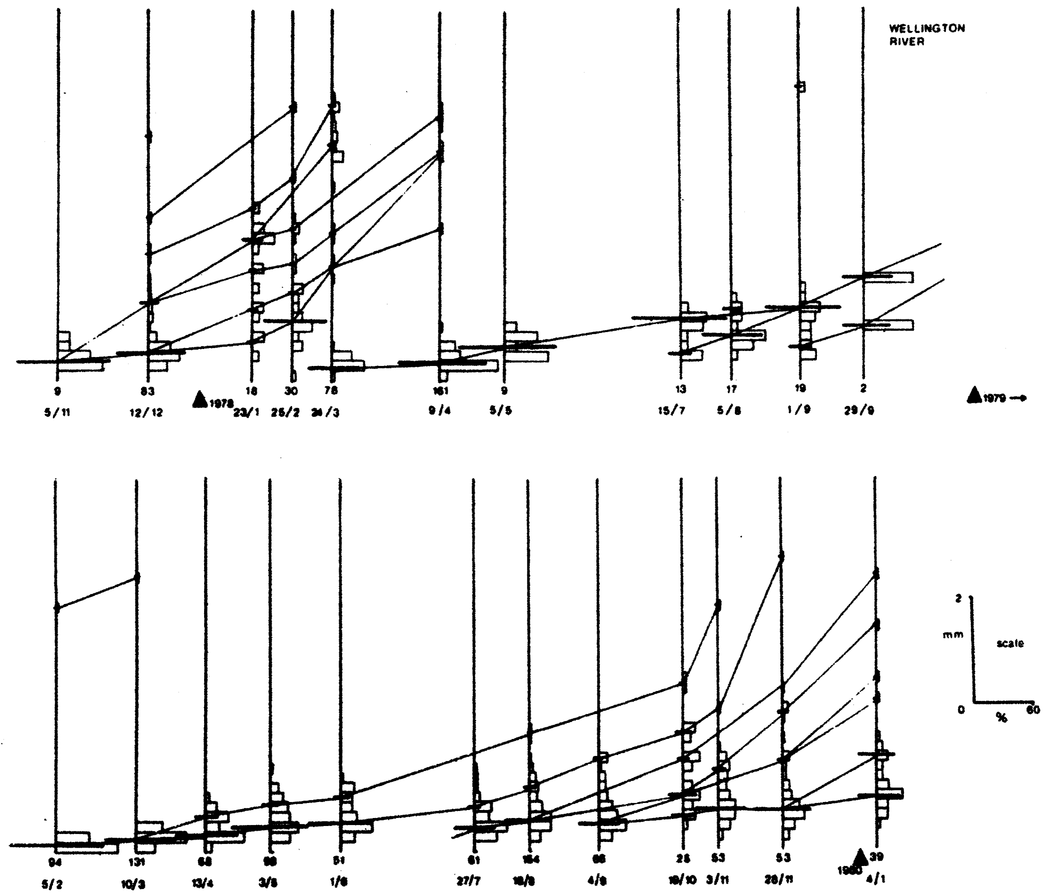

Fig. 3: Life history data for Kirrara procera at the Wellington River. Size frequency histograms indicate the percentage of nymphs in each sample present in 0.2 mm size classes. The dimension measured was combined pro- and mesonotum length. The scale lines apply to the size frequency histograms, and the distance between the histograms is proportional to the time elapsed between the samples. Numbers along the baseline indicate the number of nymphs in each sample and the day/month on which the sample was collected. Arrows indicate the beginning of each year. Superimposed on the histograms are thick horizontal lines which indicate the means of cohorts identified by the method of Cassie /1954/. The length of each of these lines indicates the relative size of each cohort. The thinner lines connecting the cohort means indicate presumed growth.

Between 29/9 1978 and 5/2 1979 no results are recorded but this was not due to an absence of sampling. No nymphs were collected during that period in spite of considerable efforts. River flows were higher than usual during this time and on each sampling trip the river level was rising and the water was quite turbid. Some indication of river flow differences between October to January of 1978/9 and the same period in other years may be obtained from Fig. 5. The Wellington River is not gauged but the data in the figure were obtained from the Macalister River, of which the Wellington River is a major tribu-

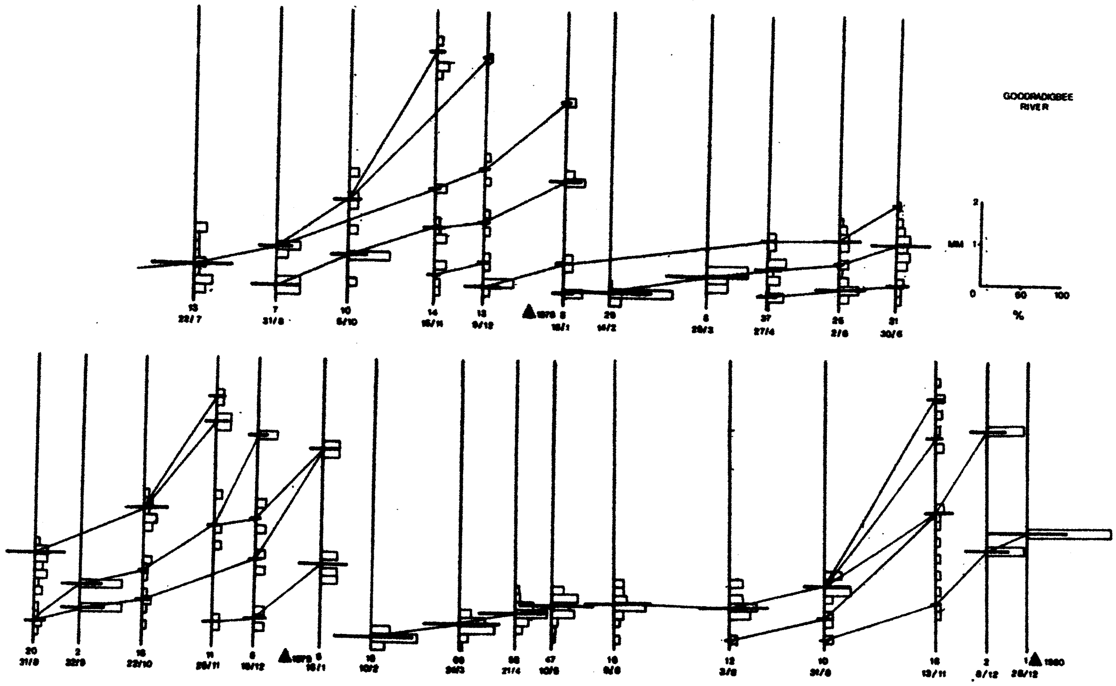

Fig 4: Life history data for Kirrara procera at the Goodradigbee River. Size frequency histograms indicate the percentage of nymphs in each sample present in 0.2mm size classes. The dimension measured was combined pro - and mesonotum length. The scale lines apply to the size frequency histograms, and the distance between the histograms is proportional to the time elapsed between the samples. Numbers along the baseline indicate the number of nymphs in each sample and the day/month on which the sample was collected. Arrows indicate the beginning of each year. Superimposed on the histograms are thick horizontal lines which indicate the means of cohorts identified by the method of Cassie /1954/. The length of each of these lines indicates the relative size of each cohort. The thinner lines connecting the cohort means indicate presumed growth.

tary at a gauging station just below the junction of the two rivers. The absence of Kirrara nymphs in the samples during this period presumably indicates a habitat shift by the nymphs in response to high flow conditions.

The large numbers of small nymphs collected in February 1979 is an indication that, although no nymphs were collected in the months prior to this there was still a normal or even better than normal emergence. It is interesting that the small nymphs appeared in the samples two months earlier in 1979 than in 1978.

The Goodradigbee River population displayed a very similar life history pattern. Mature nymphs appeared in November in the Goodradigbee population, but the emergence period was apparently shorter, since no mature nymphs were collected after January. The same patterns of nymphal growth were also evident. A large recruitment of small nymphs appeared in February each

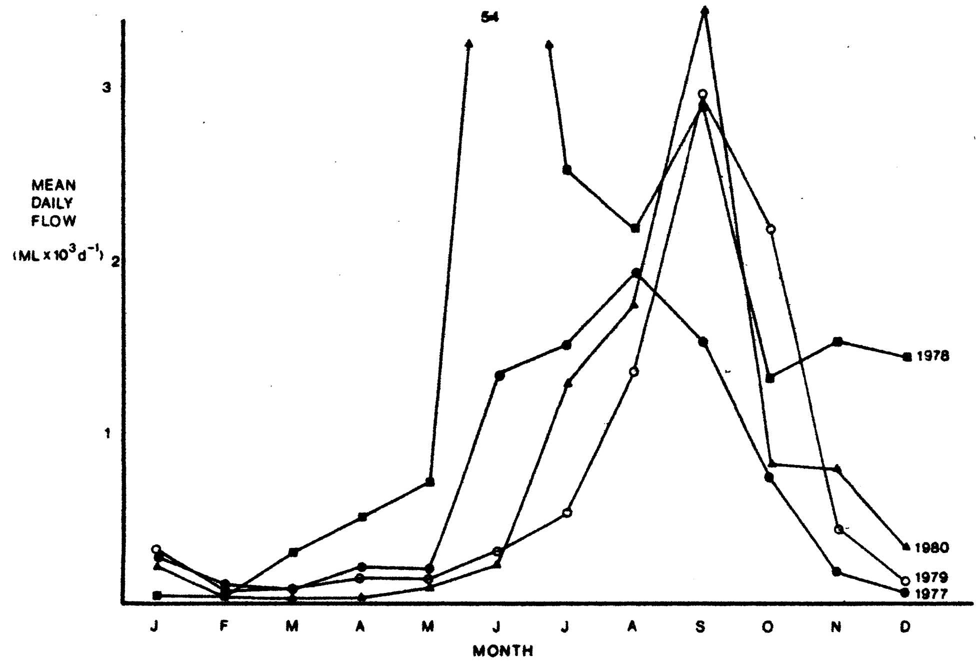

Fig. 5: The mean daily flow for each month of the Macalister River immediately below the junction of the Wellington River between January 1977 and December 1980. The units of flow are thousands of megalitres per day.

year, a month or so earlier than in the Wellington River. These nymphs grew to emerge the following summer. There was apparently also some delayed hatching, with small nymphs occurring almost throughout the year. Those which appear late in the year still complete their development by the end of the following summer.

The results found here contrast somewhat with other data on the life histories of mayflies in southern Australia. *Kirrara procera* is univoltine with nymphal development taking from five to eleven months. For much of the year, through the late autumn and winter, there is a single, fairly well-defined cohort of nymphs present, although this breaks down in spring and summer.

There is comparatively little Australian data with which the present data can be compared. However the life history pattern of *Kirrara procera* presented here is in marked contrast to the patterns found by Suter (1980) for leptophlebiid mayflies in South Australian streams and also differs from the patterns found in most of the Australian Siphlonuridae and Oligoneuriidae (Campbell, in prep.). Those studies both found multiple cohorts present throughout the year and far less synchronized life histories than were found in this study.

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