THE BIOLOGY AND ECOLOGY OF CLUBIONA SPECIES
(ARANEAE : CLUBIONIDAE) AND THEIR SCELIONID PARASITOIDS (HYMENOPTERA)

By

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SUMMARY

Spiders of the genus Clubiona are abundant under the bark of Eucalyptus trees at Mylor, South Australia, specifically E. viminalis and E. leucoxylon. *Clubiona robusta* L.Koch, the largest species at this location, has up to 9 juvenile instars. It feeds on a variety of insects that are associated with bark; and it constructs a specialized silk chamber in which it moult, overwinters, mates, lays and guards its eggs. Females lay 1-2 eggmasses per season.

Eggs are present in the field for up to 8 months of the year, from August to April. Juveniles hatch, go through 2 moult inside the nest and then disperse. The majority undertake aerial dispersal (ballooning) to reach other trees, but a few remain on the same tree and disperse by walking. Other species of *Clubiona* that coexist in the same habitat have a similar biology to that of *C. robusta*.

Adult *C. robusta* are most abundant in spring and summer, but are present at all times of the year. Generations are not discrete. There is a summer and winter generation, but spiders maturing late in summer can also overwinter to oviposit in the following spring. Mortality occurs in 2 main phases; from parasitism on eggs by Ceratobaeus mangeri sp.nov. (Scelionidae), and at the time of juvenile dispersal.

*C. mangeri* killed 22-25% of all eggs in the 3 seasons of the study. Although this mortality is high, the very similar results obtained in each season suggest that it may be constant and therefore not important in causing fluctuations in *C. robusta* populations.

Changes in the abundance of this spider are more likely to be caused by differences in mortality at dispersal. Observations in the field indicate that about 60-70% of juveniles die from landing in unfavourable habitats. It is proposed that this species has a Type IV mortality pattern (Slobodkin 1961) (i.e. very high mortality in the early life history stages), and not
Type III (i.e. a constant rate of mortality over all stages) as has been reported for other spiders.

*C. robusta* guards its eggs and the first 2 instars by attacking intruders that attempt to enter the nest. All intruders larger than 2 mm are killed. Removal of spiders from nests in the field caused almost total mortality of the unguarded eggs. *C. masneri* escaped attack; experimental evidence suggests that this may be due to the small size of this species. It never parasitizes all the eggs in an eggmass. In all observed cases eggs on the periphery were likely to die, whereas those in the centre were protected by being too deep for the ovipositor to reach.

Female *C. robusta* are more common than males in the field, but they occur in equal numbers in laboratory cultures. Behavioural trials show that males are much more aggressive than females and can kill or injure each other. Male aggression is thus believed to result in their low abundance and the biased sex ratio in this species.

Studies on the biology of *C. masneri* show that the larval and pupal stages of the parasitoid develop inside its host. The host is not completely consumed until after the larval-pupal apolysis, i.e. the parasitoid continues to feed while it is a pharate pupa. This phenomenon has not previously been described for any Hymenoptera. Individuals emerge as adults; males emerge prior to females, then wait for the latter and mate with their sibs. A limited amount of outbreeding occurs in the few eggmasses that are attacked by more than one female wasp. Ovarian development of eggs continues for several days after emergence, even though females can successfully oviposit in the interim.

Females of *C. masneri* overwinter as adults under bark and do not feed or resorb their eggs. This species, as with other parasitic Hymenoptera, displays arrhenotokous parthenogenesis and has a sex ratio biased towards the female. They can discriminate between parasitized and unparasitized eggs and also determine when hosts are too old to allow for successful development of their offspring. Host eggs can be successfully parasitized up to early
germ band stage at 15 and 20°C, but at 25°C development occurs only up
to germ disc stage, even though oviposition occurs up to germ band stage.
Transfer of parasitized eggs between temperatures indicates that high
temperature alone is responsible for unsuccessful development between
these stages.

*C. mañerii* and related species show a high degree of host
specificity. They usually attack spiders belonging to only one genus and
have a 'preference' for one species. They find their hosts by searching
for eucalypt trees and then the silk of nests under the bark. Final
location and acceptance is probably achieved by recognition of chemicals
on the surface of host eggs.

The ovipositor of *C. mañerii* is unlike that described for any other
Hymenoptera. It is invaginated into the body cavity and is detached from
the terminal segments of the metasoma. It is contained within a semi-
sclerotized membranous tube, and is connected to the metasoma by elongated
muscles and apodemes. A model for the mechanics of ovipositor movement,
including extension and retraction of the ovipositor, is proposed.

*C. mañerii* and related species have a horn-like process on their
anterior metasoma to accomodate the elongated ovipositor. These species
all oviposit through the eggsac wall to reach the eggs inside. Other
genera are wingless, have a streamlined body, a short ovipositor, and
burrow through the eggsac wall to parasitize their host eggs. These
adaptations are related to the thickness and density of the eggsacs produced
by spiders in different families. The protection of eggs through their
physical isolation by eggsacs, and the adaptations required to penetrate
them, are discussed as factors that have contributed to host specificity
in scelionid wasps.

The taxonomy of scelionids that attack the eggs of spiders is reviewed
to support the biological sections of this study. Keys to genera and specie
of *Ceratobaeus* are presented, several species are described or redescribed,
and *Hickmanella* is erected as a new genus.