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# AGE DETERMINATION OF ADULT ODONATA

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Collections of adult ♂♂ *Austrolestes annulosus, A. leda* (*Lestidae*) and *Ischnura heterosticta* (*Coenagrionidae*) were made every 2-3 days between September, 1970 and May, 1971. Sections of hind legs (4μ) were examined with a polarisation microscope. Post maturation age in days was estimated on the basis of the number of endocuticular layers. The reliability of this method is discussed by comparison with other methods of age determination.

## INTRODUCTION AND EXPERIMENTAL RESULTS

In order to evaluate field or laboratory data obtained from field insects, it is frequently necessary to know either the precise age of individual insects or at least be able to rank the insects in order of age. There are many ways by which an experienced investigator can subjectively estimate the age of individuals of a given species with which he is thoroughly familiar. Most species of Odonata undergo marked age dependent colour changes, at least during their maturation period; many undergo continual structural change in various reproductive organs. Many species show various forms of damage to their wings or integument as a result of mating, old age etc. However, these indicators of age, which have been well reviewed by CORBET (1960), may be of little or no use to the odonatologist working on small or short lived species, or one working in a climatically unstable environment, or one requiring reliably accurate data on a wide variety of species.

To date, only NEVILLE's (1967) method of counting daily growth layers in insect cuticle has provided a possible means of accurately determining the age of a large number of field insects. In the following account, the usefulness of this method to odonatologists is evaluated in the light of a study on 3 species of Zygoptera from the tablelands of eastern Australia. The characteristically cold winters of this area usually restrict the flight season of all Odonata to the months of September to May. Even during this period, weather conditions are unstable and the density of all species of Odonata flying near water fluctuates greatly.

Collections of adult male *Austrolestes annulosus, Austrolestes leda* (*Lestidae*) and *Ischnura heterosticta* (*Coenagrionidae*) were made every 2 or 3 days from Dangar's Lagoon (Lat. 30°41' Long. 151°30') between September 1970 and May 1971. After each collection, a hind leg was removed from each individual, soaked in water for 1 hour or more and sectioned at 4$\mu$ with a "Lipshaw 1500" cryotome. About 25 sections were mounted in water and examined with a Zeiss research microscope between crossed polaroid filters. Thus viewed, the endocuticle, distinguished from the exocuticle by lack of pigmentation, showed a pattern of alternating light and dark bands (Figs. 1 and 2) divided into quadrants in such a way that any one band, if perfectly formed, was bright in opposite quadrants and dark in the other 2 quadrants (cf. e.g. Fig. 3).

Age in days was estimated by counting the number of pairs of light and dark

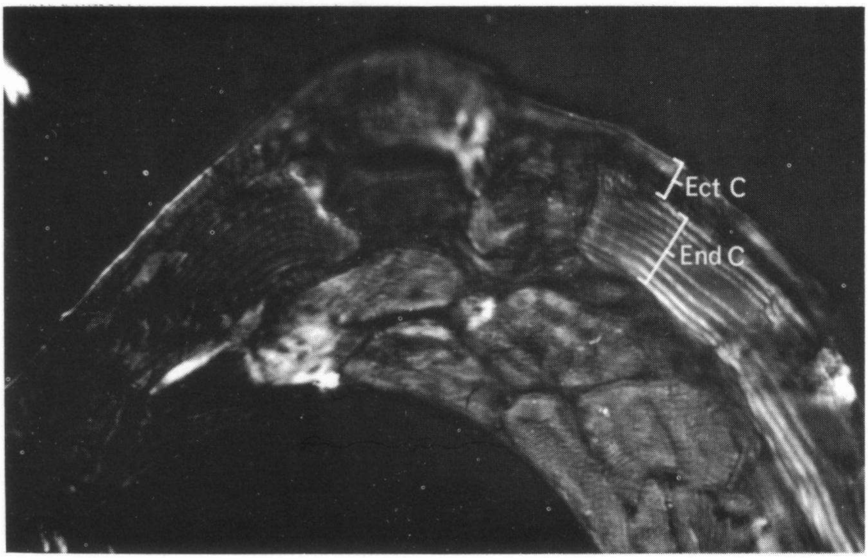


Fig. 1. Transverse section of a hind tibia of an adult *Austrolestes annulosus* cut with a cryotome, showing endocuticular growth layers. Ect C = ectocuticle; End C = encocuticle. Age = 9 days.

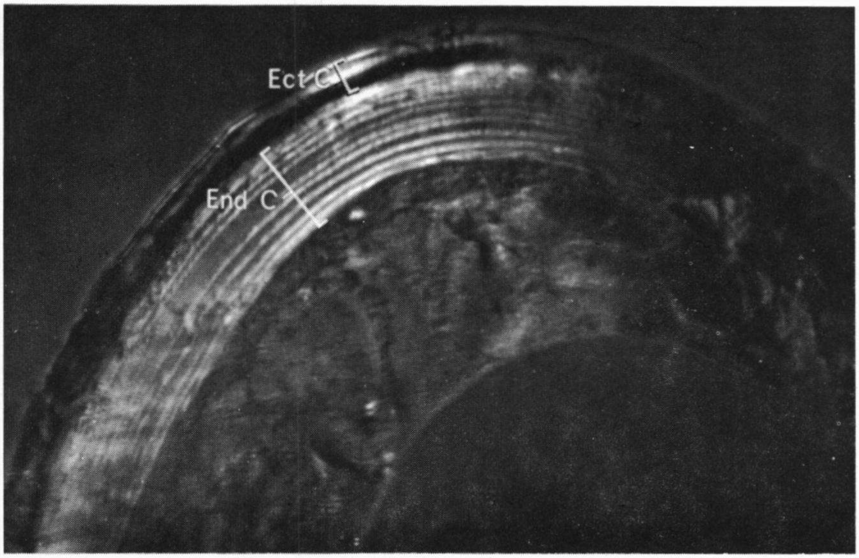


Fig. 2. Transverse section of a hind tibia of an adult *Ischnura heterosticta* cut with a cryotome, showing endocuticular growth layers. Labels as in Figure 1. Age = 10 days.

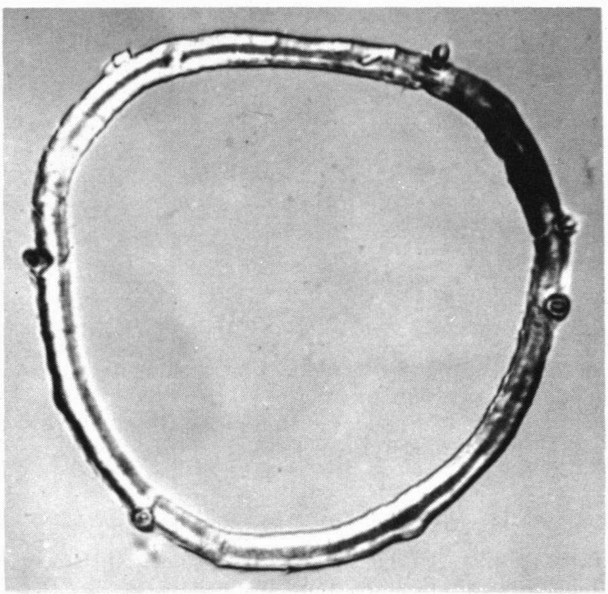

Fig. 3. Transverse section of a hind tibia of a teneral *Ischnura heterosticta* before the endocuticle has started development.

layers in the endocuticle. The method was verified in the laboratory by counting cuticular layers of hind legs of 6 individuals of each species removed on successive days.

The combined results of all age determinations are shown in Figure 4. Twenty-two per cent of the *A. leda* examined had cuticular layers that appeared too diffuse for accurate interpretation and are recorded in Fig. 4B as estimates

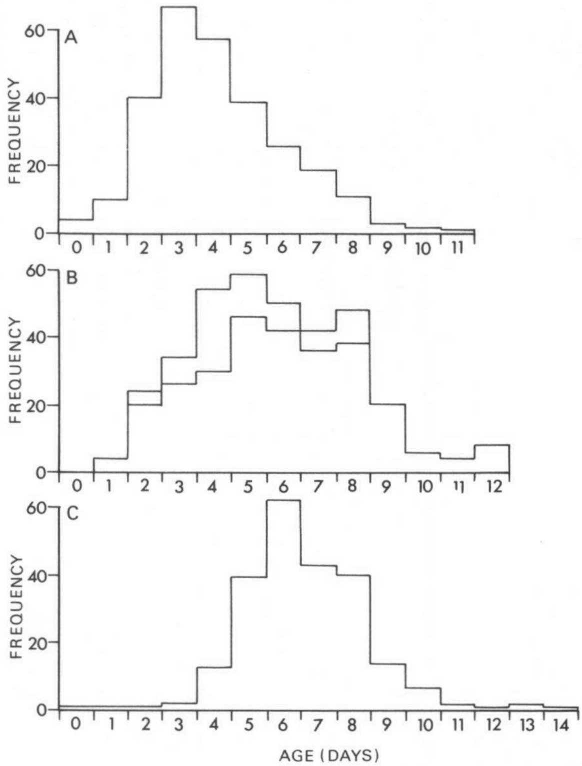


Fig. 4. Age, in days, since the end of the teneral period of *Austrolestes annulosus* (A), *Austrolestes leda* (B) and *Ischnura heterosticta* (C) collected at Dangar's Lagoon between December, 1969 and April, 1970 (cf. text). Twenty-two per cent of the *A. leda* examined are recorded as estimates only and make up the difference between the upper and lower columns of histogram B.

only. There was little variation in either longevity or percentage age distribution between species studied; neither was there any consistent seasonal variation in mean age (Fig. 5). Teneral individuals showed little or no sign of any endocuticle formation (cf e.g. Fig. 3). Thus, in the species studied, age estimates apply to the maturation period only, not to the whole adult age.

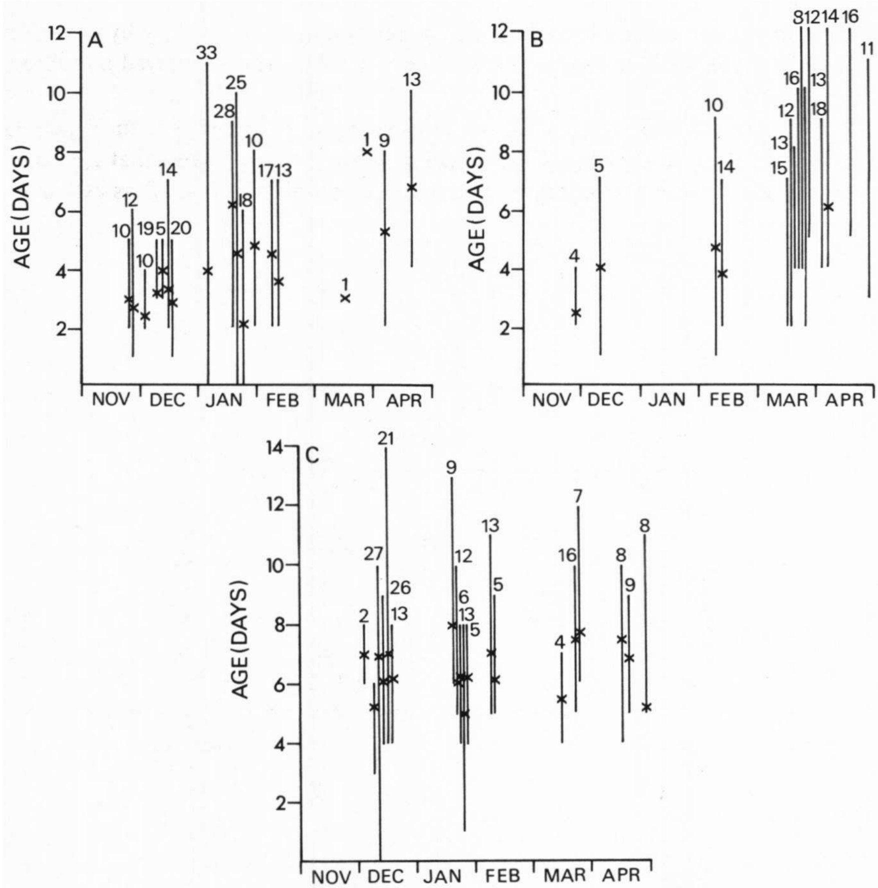


Fig. 5. Seasonal change in ranges (vertical lines) and means (crosses) of samples (with N indicated) of *Austrolestes annulosus* (A), *Austrolestes leda* (B) and *Ischnura heterosticta* (C) collected at Dangar's Lagoon between November, 1969 and April, 1970 (cf. text). Means for *A. leda* amples are not given where age estimates are included.

## DISCUSSION

In the absence of mark and recapture data or of other means (e.g. observing size and colour change of ectoparasitic mites, MITCHELL, 1970) of recognising age change in the species studied, only estimates of the maximum duration of the maturation and post-maturation periods and of total longevity in other species, can be used to evaluate the reliability of the present ageing method. These periods in the Odonata (cf. review by CORBET, 1960, and discussion by

Table I

Estimates of the maturation and post-maturation periods and the total longevity of Odonata. FE - MA = Period between first (or peak) emergence and first (or peak) appearance of mature adults. LE - LA = Period between last emergence and last adults, including variations on this method (see text). M and R = Mark and recapture or observation of marked individuals. N = Number of insects observed (stated only where this is low)

| FAMILY<br>*Species* | Maturation period<br>*max.* | <br>*mean* | Postmaturation period<br>*max.* | <br>*mean* | Total longevity<br>*max.* | <br>*mean* | Method | References |
|---|---|---|---|---|---|---|---|---|
| COENAGRIONIDAE | | | | | | | | |
| *Pyrrhosoma nymphula* | range: 9-15 | | 31 | 6.7 | 46 | 21.7 | M and R | CORBET, 1952 |
| *Enallagma civile* | | | | 3.5 (♂)<br>3.1 (♀) | | | M and R | BICK & BICK, 1963 |
| *E. praevarum* | | | 10 (♂)<br>8 (♀) | 5.0 (♂)<br>5.5 (♀) | | | M and R | JOHNSON, 1964 |
| *Ischnura damula* | | | | | Several days max. | | LE - LA | JOHNSON, 1964 b |
| *I. heterosticta* | | | 14 | | | | growth layers | this paper |
| *Argia apicalis* | | | 33 (♂)<br>28 (♀) | 8.4 (♂)<br>7.0 (♀) | | | M and R | BICK & BICK, 1965 |
| *A. moesta* | range: 7-14 | | | approx. 7 | approx. 21 | | M and R, and observation | BORROR, 1934 |
| *A. plana* | | | 40 (♂)<br>36 (♀) | 10.9 (♂)<br>7.7 (♀) | | | M and R | BICK & BICK, 1968 |
| LESTIDAE | | | | | | | | |
| *Austrolestes annulosus* | | | 11 | | | | cuticular growth layers | this paper |
| *A. leda* | | | 12 | | | | cuticular growth layers | this paper |
| *Lestes disjunctus* | | 13 | 50 | 10 | | | M and R | BICK & BICK, 1961 |
| *L. rectangularis* | | 21-24 | | | | | FE - MA | GOWER & KORMONDY, 1963 |
| | | | | | at least 24 | | LE - LA | |
| *L. sponsa* | | 16 | | | | | FE - MA | CORBET, 1956 |
| | | | | | 69 | | prelim. M and R | |
| HETAERINIDAE | | | | | | | | |
| *Hetaerina americana* | | | | 28 | 14.3 | | M and R | JOHNSON, 1962 |
| CALOPTERYGIDAE | | | | | | | | |
| *Calopteryx splendens* | 2 | | | | | | ? | Zahner, 1960 (*in* CORBET, 1962) |
| PETALURIDAE | | | | | | | | |
| *Tachopteryx thoreyi* | | approx. 14 | | | | | FE - MA | Williamson, 1900 (*in* WOLFE, 1953) |
| AESHNIDAE | | | | | | | | |
| *Anax imperator* | 7-12<br>13-16 | 9 (♂)<br>15 (♀) | | | | | FE - MA | CORBET, 1957 |
| | | | at least 26, possibly 45 | | | | M and R | |
| CORDULIIDAE | | | | | | | | |
| *Tetragoneuria cynosura* | | 14 | | | | | FE - MA | KORMONDY, 1959 |
| LIBELLULIDAE | | | | | | | | |
| *Libellula depressa* | | | | | 35 | | M and R (N = 6) | |
| *L. quadrimaculata* | | | 18 | | | | M and R (N = 4) | MOORE, 1952 |
| | | | | | 48 | | LE - LA | |
| *Orthetrum cancellatum* | | | 22 | | | | M and R (N = 6) | MOORE, 1952 |
| | | | | | 48 | | LE - LA | |
| *Plathemis lydia* | 8-14 (♂)<br>13-24 (♀) | | 34 (♀) | | | | M and R | JACOBS, 1955 |
| *Sympetrum striolatum* | | | 29 | | | | M and R (N = 5) | MOORE, 1952 |

GAMBLES, 1960) have been determined by two principal methods:
(1) The minimum maturation period of species which have a short, well-defined emergence time can be estimated as the period between first (or peak) emergence and first (or peak) appearance of mature adults (Williamson, 1900, *in* WOLFE, 1953; CORBET, 1952, 1956, 1957; KORMONDY, 1959 and GOWER & KORMONDY, 1963). The maximum total longevity can be estimated as the period between the last, or last common (JOHNSON, 1964b) emergence, or last teneral (MOORE, 1952) and the last, on last common, flying adult.
(2) Mark and recapture methods may be employed to measure the maximum duration of the post-maturation period (BORROR, 1934; CORBET, 1953, 1957; JACOBS, 1955; BICK & BICK, 1961, 1963, 1965a, 1968 and JOHNSON, 1962, 1964a). If adults, just after exuviation (JACOBS, 1955) or teneral adults (BORROR, 1934 and BICK & BICK, 1961) are marked, or if the maturation period has been determined by other methods, total longevity can also be calculated (CORBET, 1952, 1957).

The combined results of these studies (Table I) reveal very wide interspecific variations which appear to be more dependent on locality than on taxon. It is thus concluded that, until mark and recapture studies and cuticular layering studies are carried out simultaneously in the field, the validity of the results obtained by the latter method must remain unverified. However, with the exception of some *A. leda*, the endocuticular layers observed in the present study were always clear and well formed; there was little evidence to suggest that their growth was decreased, either by weather conditions or by increasing age.

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