

A Cautious Univoltine Strategy in the Lacewing *Nineta flava* (Scopoli) (Neuroptera, Chrysopidae) *

**By Michel CANARD, Toulouse
Université Paul-Sabatier, Labo. d'Entomologie**

ABSTRACT

A strain of *N. flava* originating from the southern part of its distribution area exhibited a single brood in a year. In the laboratory, the larvae entered always diapause within the cocoon, independently of the photoperiod rearing conditions. The extended duration for adult emergence after overwintering outdoors depended on the photoperiod monitored by the larvae developing before the prepupal diapause: short-day light conditions offered to them induced a hasty spring appearance and reversely. Besides, the long spread of egg-laying time may be due to the occurrence of an imaginal reproductive diapause displayed to certain females by long-day.

The combination of these two acting factors: (i) ensures to the species a long-time occurrence in nature (imagos from May to October), (ii) gives it the phenological look of the multivoltinism, and (iii) prevents by contradictory results and by the variability in imaginal responses the break of the population into separate sympatric biotypes.

INTRODUCTION

During their evolution, the insects found out various solutions to the problems encountered in their environment, particularly facing the climate, the food availability, the competitors. The variety of the ecological situations gave rise to a crowd of strategies in which every species takes a place, sometimes out of the too restrained schemes thought out by the entomologists. The lacewing *Nineta flava* (SCOPOLI) is an example of our lack of understanding such a diversity in life histories of chrysopids.

A general overlook on the phenological data related to this species immediately makes evident six main points: (i) the emergence of adults occurs from spring, (ii) but it is also possible to observe freshly emerged adults during the last part of summer, (iii) and thus, the species is present as imagos until October; (iv) the growing larvae, besides, are found up to autumn; (v) on the other hand, the eggs do not appear before the beginning of summer, (vi) and all attempts to rear the larvae reported by the authors always achieved a prepupal diapause.

* This lecture (S 22-2/20) is based on two papers previously published (see references) in which more detailed data and references are given.

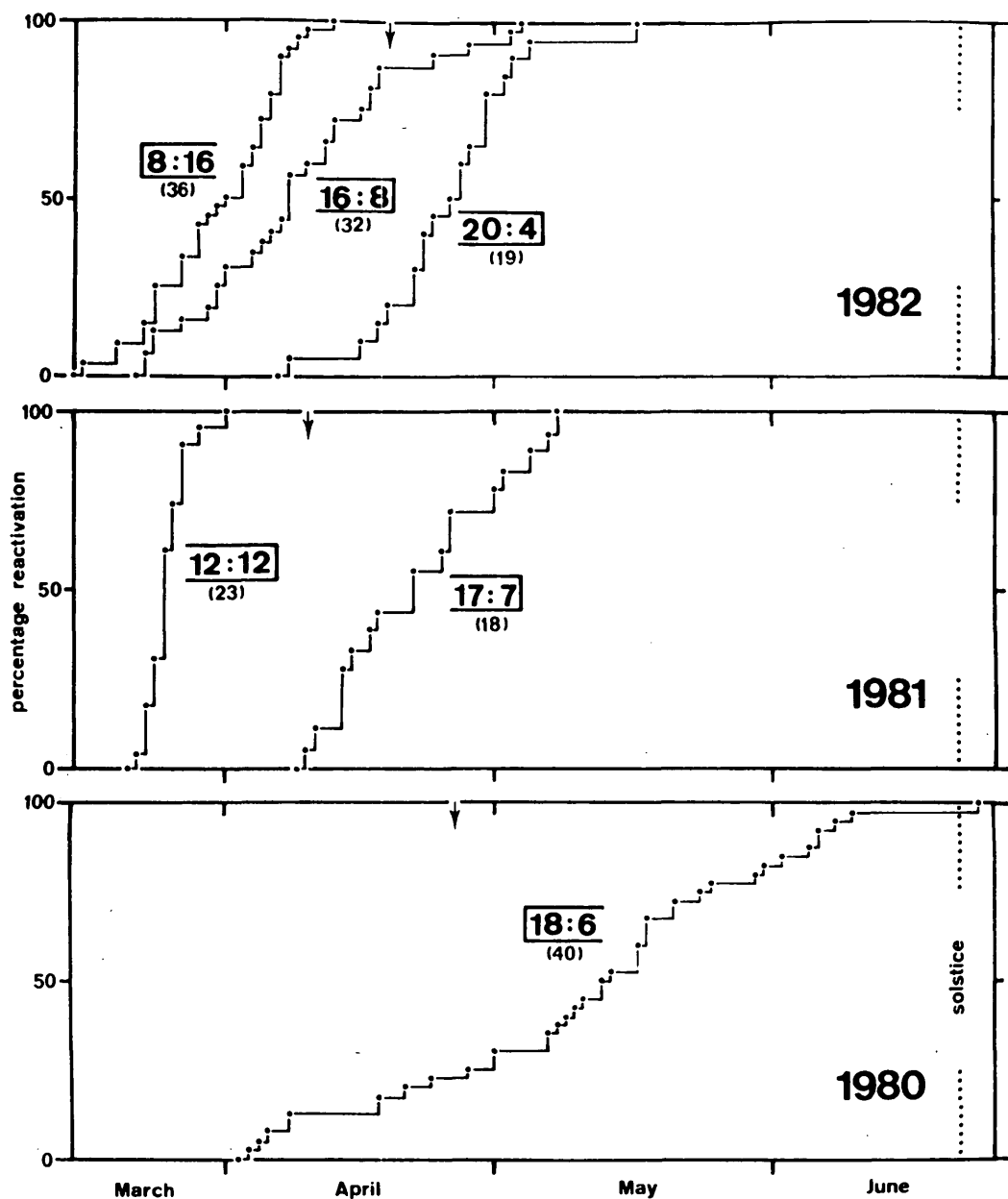


Fig. 1 - Timing of pupal ecdysis in *N. flava* prepupae put in the field, after cocoon removal and overwintering outdoors, related to the photoperiod (L : D) used during larval rearings in the laboratory at 20°C. Sample sizes in brackets (after CANARD, 1983).

In spite of the contradictions revealed by the two last observations, the conclusion regarded as logical or at least the less unrealistic was that involving bivoltinism, either facultative (e. g. ASPÖCK & ASPÖCK 1964) or even, more recently, constant (e. g. ZELENÝ, 1984). We are demonstrating that the reality is quite different, at least in the

strain studied in the southwest of France. At first view, it is in accordance with the stated general patterns; but its life cycle is strictly univoltine and it has adopted original mechanisms which enable it to fill space all along the growing season.

RESULTS AND DISCUSSION

1 - The voltinism

The larval development of **N. flava** in all cases goes on with a prepupal diapause. Though the concept of "obligatory diapause" is not well accepted, its use is here inviting. All the trials carried out to obtain a breakless development were unsuccessful. In the laboratory a lot of larvae ($n = 672$) were submitted to various controlled conditions: the photoperiods experienced ranged from permanent dark to continuous light - namely 0, 8, 12, 16, 17, 18, 20 and 24 hours of light per day - and included increasing daylight, the temperatures were comprised between 10 and 28°C. A sole response appeared in the whole population: it was a strong diapause of the full-grown larvae within the cocoons ($n = 523$ cocoons produced with a mean yield of 0.78). When reared in nature, either in early or in late summer, all the individuals also entered diapause as prepupae ($n = 96$ cocoons).

It may be objected that feeding factors and/or the combination of alternate temperatures and light conditions could break such a situation. This seems improbable in consideration of the perfect homogeneity in the response. Neither does it seem reasonable to believe that the individuals which died during the experiments, especially at high temperature - they reached 43 % of the reared larvae at 28°C - were only those able to develop without diapause.

So we are tempted to call the larvae of **N. flava** photo-insensitive. If that reflects the actual situation before diapause, it is not fully true, because the influence of the photoperiod is delayed and only appears after overwintering. This is the second key point in the life cycle of **N. flava**.

2 - The larval photosensitivity

The emergence time of the adults is correlated to the photoperiod conditions monitored by the larvae during their weight growth, i. e., their predaceous life part. The mechanism of this interaction has been revealed as following. Larval rearings were carried out in laboratory under various daylengths; the resulting diapausing cocoons were put outdoors where they overwintered. The reactivation which occurred the following spring was timed by observing the appearance of the larval exuvium as a black spot at a pole of the cocoon. In order to avoid eventual disturbances due to a genetic and/or a physiological spring of heterogeneity, the larvae were only kept for analysis (i) when coming from the same laying females, thus being sister prepupae, (ii) when coming from eggs laid in a short period, (iii) and reared at the single temperature of 20°C.

The results (Fig. 1) show that if the larvae came under short-day light conditions, they terminated diapause early in spring; whereas conversely, if they developed under long-day, their reactivation occurred later. The threshold of critical photoperiod was estimated around 16 hours of light a day.

The time lag between the three years was induced by the variations in the meteorological circumstances. An approximate reference is indicated on the diagrams by the arrow which dates every year a well synchronized event, namely the appearance in nature of the first male of **Chrysopa perla** (L.) as a check.

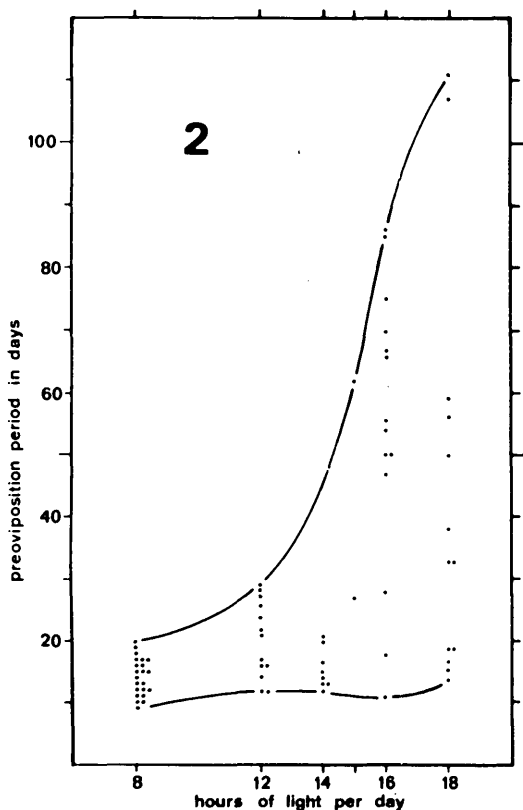


Fig. 2 - Preovipositionary time in days of *N. flava* females reared at 20°C under various photoperiod conditions (after CANARD, 1982).

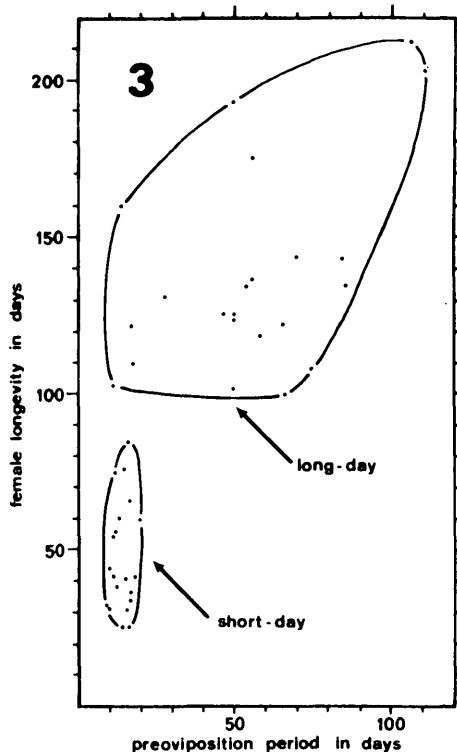


Fig. 3 - Longevity of the normally inseminated and fertile females of *N. flava* submitted to short- (8:16) or long-day (16:8 and 18:6) light conditions related to their preoviposition period (after CANARD, 1982).

3 - The extended diapause

Another feature capable of being a casual ecological advantage is the feasibility to enter a prolonged diapause, thus extending it to the second spring to be broken. This two-year cycle is very scarce and occurs irregularly when overwintering takes place in natural conditions. But it is, however, possible. And it becomes much more easily disclosed if the reactivation is tentatively induced by an artificial winter provided by storing the cocoons during 4 months at a low temperature comprised between 0 and 4°C. In our experiments on this topic, it concerned about two thirds of the diapausing prepupae from a rearing carried out at 20°C, under long-day.

4 - The delayed oviposition and the related imaginal longevity

The total range of adult emergences is not really more than 2 or 2.5 months in nature, and thus cannot explain by itself the misunderstood phenological data recorded for *N. flava*. There is another modifying factor in the cycle course which can be expressed as follows: some females may exhibit a reproductive diapause, in this case induced by long-day.

Figure 2 shows the preoviposition period of females reared together with males under various photoperiod conditions at 20°C. The pattern of the distribution calls for two comments: (i) it might be a conspicuous increase in the time necessary for laying the first egg when the daylengths tended to long or very long days, (ii) and there is, moreover, a large diversity in the individual responses resulting from a strong polymorphism with respect to this character.

Correlatively, the female longevity increased in the same proportion (Fig.3). Under short-day conditions, the females normally inseminated and demonstrating a high fecundity lived from 3 weeks to 3 months, around a mean of 1.5 months. When submitted to long-day, the life span of females ranged from approximately 100 to more than 200 days.

CONCLUSION AND SUMMATION

We conclude that the studied strain of *N. flava* is really univoltine. But it exhibits particular adaptation joined to a beneficial heterogeneity permitting it to exploit the resources of its environment as a multivoltine species does, and to avoid the difficulties which might occur at certain times. So, the classical ontogenic polymorphism of many chrysopid species the larvae of which are predaceous and the adults glycophagous is completed by other polymorphic features giving it a favourable biological plasticity.

The hazard of such an evolution would be the separation of the population into several independent biotypes. We must note that the above mentioned regulating factors are balanced in order to prevent it. Indeed, from larvae living under short-day - in late summer or even in fall - are obtained adults early emerged, which thus have all chances to give rise to a larval brood submitted to long-day in early summer. These will have at that time a longer diapause and will be the next year the last emerging adults. They will reproduce later, particularly if the imaginal diapause occurs. By this means, a continuous mixing in the potentialities of the species is ensured.

Finally, the study of *N. flava* gave us the opportunity to display evidence for some biological characters unknown until now in chrysopids. They are: (i) a possible double diapause in the individual development, (ii) a facultative reproductive diapause induced by long-day light conditions, (iii) a possible extended prepupal diapause bearing the life cycle to two years, (iv) a larval photosensitivity the effect of which is delayed at the end of or after the prepupal diapause, participating in the regulation of the adult emergence time.

Acknowledgements

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Address of the author: Dr. Michel C a n a r d
Labo. d'Entomologie (UA 333 CNRS)
Université Paul-Sabatier
118 route de Narbonne
F-31062 Toulouse Cedex, France

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