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# Winter diapause in a Mediterranean population of *Pisaura mirabilis* (Clerck) [1].

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## Introduction.

In entomology, diapause has been defined as "a temporary interruption of development which, in a given species, would occur even if the insects were kept under optimum conditions" (Novák, 1966). The phenomenon may be regarded as a winter survival mechanism (Danilevskii, 1965).

As defined, diapause is almost unknown in the Arachnida except in certain of the Acari (Lees, 1955; Danilevskii, 1965). Various species of spiders become difficult to rear in the laboratory during winter, a fact that suggests the existence of diapause in these species. Witt *et al.* (1968, p. 40), for example, report that laboratory cultures of orb weavers suffer unusually high mortality and spin very few webs in the winter in spite of imaginative manipulation of temperature, humidity, and photoperiod in the cages. Dondale (unpublished) finds that the crab spiders *Philodromus rufus* Walckenaer and *P. cespitum* (Walckenaer), which in regions with short, cool summers hibernate twice during immature life, fail to develop in the laboratory if brought inside at the beginning of their first winter. Nearly-mature spiders that are about to enter their second winter can be reared to maturity in two or three weeks if submitted to a long photoperiod. Apparently a period of dormancy is required early in the life of these spiders. Schick (1965, p. 5) also notes an autumn or winter "diapause" in certain Thomisidae in which moulting ceases and feeding is greatly reduced. Miyashita (1969a) observes that the Japanese wolf spider *Pardosa t-insignita* (Boesenberg & Strand) requires 12-14 days to resume development when brought into the laboratory in November or December at Tokyo. This interval begins to shorten in January, and is virtually eliminated by mid-March. He postulates a two-month "diapause" in *P. t-insignita,* during which the spider may be active in the field whenever sunny weather prevails. Miyashita (1969b), in a second study, suggests that the unusually long period of time spent in a particular instar by laboratory-reared *Plexippus setipes* Karsch may be the expression of an intrinsic winter diapause.

The principal criterion of insect diapause is the measurable suppression of metabolic rate and of development (Novák, 1966; Beck, 1968). In this paper we apply this criterion, as indicated by changes in oxygen consumption, live weight, and sexual maturity, to a population of the spider *Pisaura mirabilis* (Clerck) at Montpellier (Hérault), France

*P. mirabilis* is a univoltine, spring-maturing spider, widespread in weedy fields, meadows, and open woods of the Palaearctic region. The eggs hatch in May or June, and the young on emerging build tiny webs (Lenler-Eriksen, 1969) but later take up an errant life. Like *P. t-insignita* of Japan, *P. mirabilis* runs actively in sunny weather throughout the autumn and winter at Montpellier (43° 36′ north; duration of daylight at summer solstice 15 hours 29 minutes, at winter solstice 8 hours 53 minutes), and is sometimes seen feeding as well.

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[1] Contribution No. 573, Research Institute, Canada Department of Agriculture, Belleville, Ontario and Laboratoire de Zoologie, Faculté des Sciences, 34-Montpellier, France. A short account of this work appeared in Compte Rendu Acad. Sci. Paris 270: 2483-2485 (20 May 1970). The findings are presented here in more detail in view of the interest among English-speaking arachnologists in the problems of winter rearing.

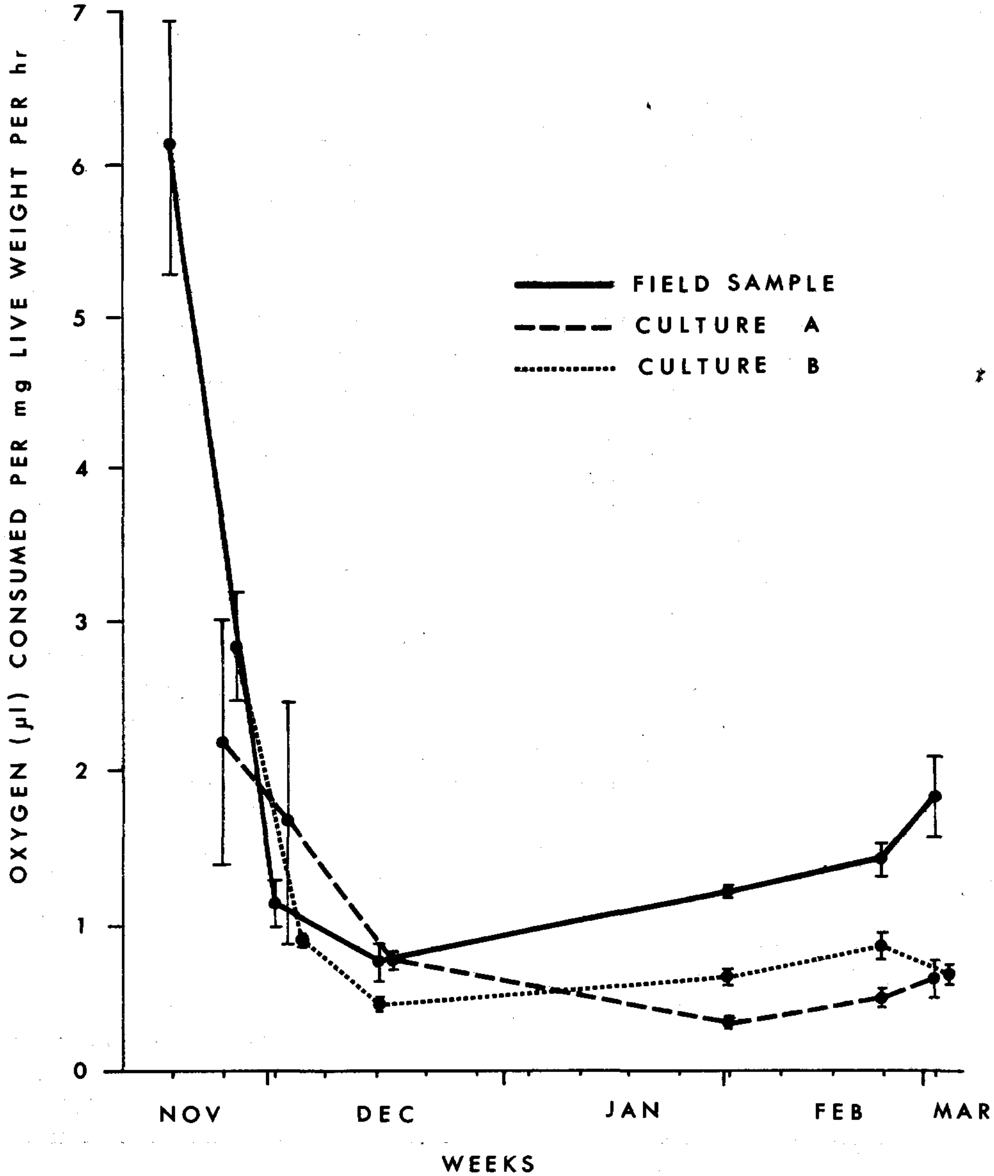


FIG. 1. Oxygen consumption in *Pisaura mirabilis* (Clerck) at Montpellier, France, 1969-70. Culture A under prevailing photoperiod (15 hr 29 min on 21 June, 8 hr 53 min on 21 Dec), B under 16-hr photoperiod. Sample size = 20 (field) or 10 (laboratory). Vertical lines indicate size of standard error.

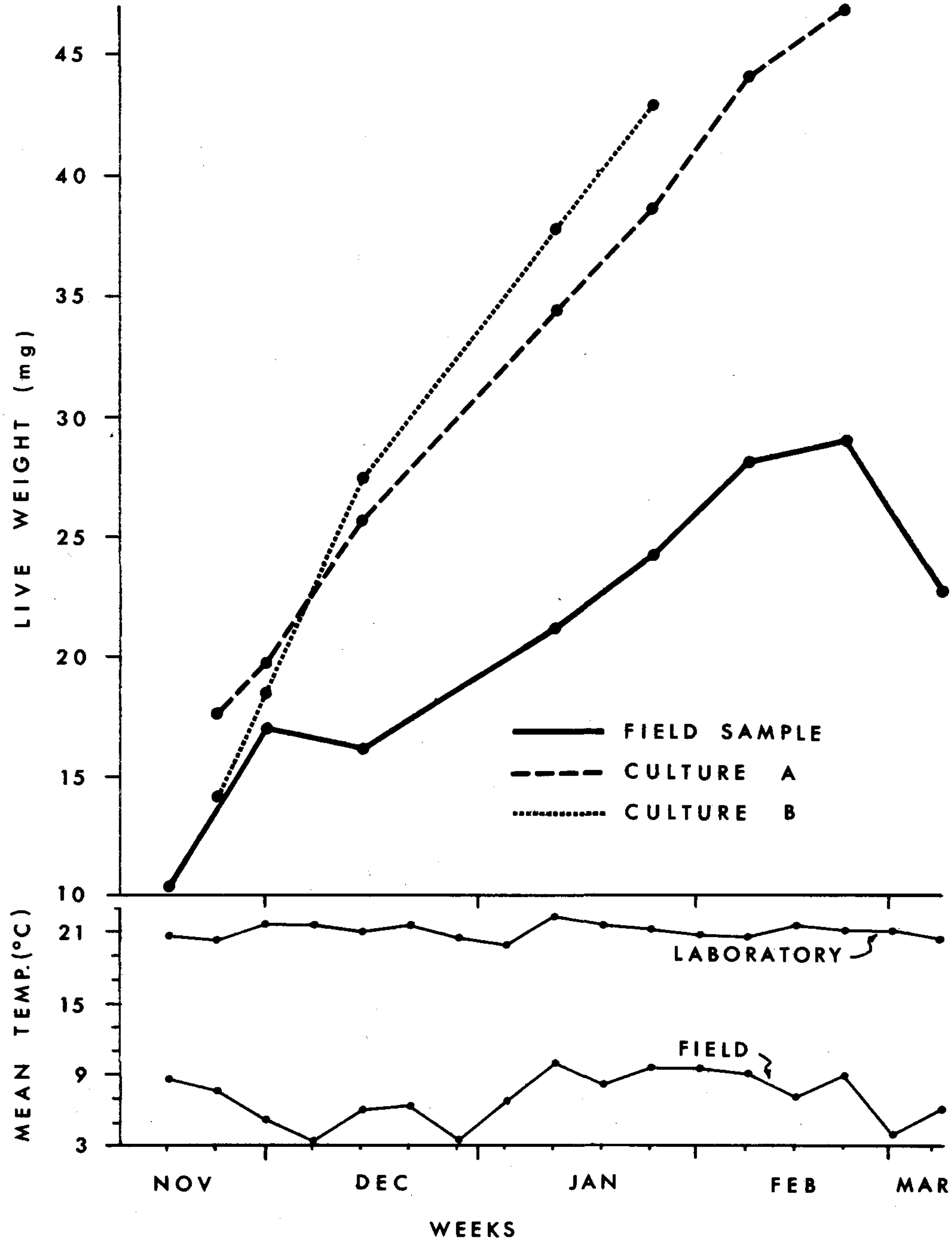


FIG. 2. Mean live weight in *Pisaura mirabilis* (Clerck) in relation to temperature at Montpellier, France, 1969-70. Culture A under prevailing photoperiod (15 hr 29 min on 21 June, 8 hr 53 min on 21 Dec), B under 16-hr photoperiod. Sample size = 20 (field) or 10 (laboratory). Standard error = 3-12% of mean.

participate in an exchange of scientists between Canada and France.

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## BOOK REVIEW

### P. Weygoldt (1969). *The Biology of Pseudoscorpions.*

**Pp. xiv + 145; 114 photographs and text figures. Cambridge: Harvard University Press; London: Oxford University Press. Price £2.90**

The book is a revision and an expansion of the author's earlier German edition (1966: *Moos-und Bucherskorpione,* Die Neue Brehm-Bucherei. Wittenberg: A. Ziemsen Verlag.). Some sections, especially those on physiology and ecology, are fragmentary since little attention has been paid to these aspects in the past. Chapter 5 accounts for about half of the book and it is here that Weygoldt is most at home, describing his own notable contributions to our knowledge of pseudoscorpion reproduction and development.

Concise but comprehensive accounts are given of spermatophore formation, sperm transfer and mating dances, where they occur, among species drawn from all three sub-orders. Differences in embryonic development are elaborated with attention focussed on that unique structure, the pumping organ, which absorbs nutritive fluid from the transformed ovary whilst the embryos lie in a brood sac attached to the female's genitalia. The simple and direct text, not only of this chapter but, indeed, of the whole book is magnificently supported by photographs of high definition and drawings of superb quality.

Champagne normally comes in a bottle, sometimes, as in this case, it is contained in a book. With its up-to-date bibliography it will remain a standard biological text on the order for many years to come without losing any of its effervescence. Order a copy from your wine merchant now!

Peter D. Gabbutt

**Methods.**

Twenty active, immature spiders were collected, weighed, and used for oxygen consumption determination in mid-November of 1969. The respirometer, a Gilson GRP 14, (*cf.* recent studies with this instrument by Anderson (1970) and by Lawton and Richards (1970)), was operated at a bath temperature of 20°C and with 0.2 ml of a 20% solution of KOH in each reaction vessel. A temperature stabilization period of 60 minutes was allowed. Live weights were determined by means of a Mettler B5 balance. The spiders were then divided into two lots, both fed at the same rate and held at 20-22° C, one of them (culture A) being exposed to the photoperiod prevailing at that latitude and the other (culture B) to 16 hours of incandescent light daily (5:00 hours to 21:000 hours). The 16-hour photoperiod was used in order to determine if long days would permit development of sexually-mature individuals in winter. Additional collections of *P. mirabilis* were similarly tested and added to the cultures during the winter, and spiders from the laboratory cultures were tested for oxygen consumption at intervals as were those from the field.

**Results**

Respirometry data for the field samples and laboratory cultures are given in Figure 1. From a mid-November level of 6.12 microlitres/mg/hr, oxygen consumption declined by approximately 90% by mid-December in all three lots. Measurements could not be made in January owing to unavailability of the respirometer, but a slight rise was detected in the field sample and long-day culture in early February. The spiders under prevailing photoperiod showed a similar rise on a later date. The rather sharp rise in oxygen consumption in the early-March sample from the field was related to a significant decline in mean weight (Fig. 2); the latter apparently resulted from the unexplained and nearly complete disappearance of the largest spiders in the population.

Both field and laboratory spiders gained weight during the winter (Fig. 2), those in the laboratory gaining approximately twice as fast as those in the field. No moulting was observed in the field until 27 February, however, when subadult males with swollen palpi began to appear. The same stage was observed in the laboratory culture under prevailing photoperiod on 30 January, and, in the culture under long photoperiod, one month earlier. Sexually-mature adults were produced only in the last mentioned culture (as of 13 March). These began to appear on 7 January. Spiders that were brought inside during the period November to February moulted either two or three times (usually two) in achieving maturity. The time required for 50% of a collection to achieve the first moult on being brought into the laboratory was 17 or 18 days in November and December, 8-13 days in January, and two or three days in mid-February. The period for spiders reared under long photoperiod did not differ statistically from those under short photoperiod.

**Discussion.**

It appears that *P. mirabilis* undergoes some kind of winter diapause (or, as Müller (1965) may term it, a kind of dormancy), even in regions of short, mild winters. The rather sudden decline in oxygen consumption in November and December, as well as the interruption of sexual development, indicate this to be so. Winter growth in the field at Montpellier is probably an adaptation to mild winters; the laboratory culture under prevailing photoperiod returned to normal development earlier than did the field population as a result of higher temperatures. The appearance of sexually-mature individuals under long-day laboratory conditions in January, however, suggests that the spiders in this culture resumed development at some time in December. Perhaps dormancy could be prevented entirely if individuals experienced a long photoperiod throughout life.

Although we cannot draw any firm conclusions from this work regarding the influence of photoperiod on dormancy in *P. mirabilis*, we believe that photoperiod is one of the environmental factors that must be taken into account in winter rearing.

**Acknowledgments.**

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