CONSIDERATIONS ON AN AUTUMN RECORD OF *LESTES* LARVAE IN ITALY (ZYGOPTERA: LESTIDAE)

E. ROTA[1] and G. CARCHINI[2]

[1]Dipartimento di Biologia Animale e dell'Uomo, Università degli Studi di Roma "La Sapienza", Viale dell'Università 32, I-00185 Roma, Italy
[2]Dipartimento di Biologia, II Universjtà di Roma "Tor Vergata", Via Orazio Raimondo, I-00173 Roma, Italy

Abstract — Autumn findings of *Lestes* larvae in a freshwater pool in Apulia, southern Italy are reported and discussed. Since all European members of this genus have a long embryonal diapause, lasting from the end of the summer to the following spring, it is tentatively concluded that this unusual occurrence is due to premature hatching, and that diapause was affected by temperature and by immersion.

Introduction

It is well known that the genus *Lestes* is one of the few groups of odonates in which embryonal diapause occurs frequently. This allows the species to colonize unstable habitats, as diapause can occur during the period that is unfavourable for the survival at the larval or adult stage. Thus, the temporal characteristics of the diapause assume an evident adaptive meaning. The diapause is controlled by different environmental factors and different types of mechanisms enable the species to colonize various kinds of habitats (WIGGINS et al., 1980). All six European species have a long embryonal diapause that lasts from the end of summer to the beginning of the spring of the following year and allowing them to colonize temporary habitats, represented by pools that are typically filled with water in winter. Because of this situation, *Lestes* larvae do not occur in the pools during autumn months.

During the 1983-1984 odonate survey of the Nature Reserve "Le Cesine", Apulia, southern Italy (cf. CARCHINI et al., 1986), we have discovered, in autumn, in one of the biotopes analyzed, numerous *Lestes* larvae. This paper gives a thorough account of this unforeseen finding and of its implications for our understanding of the regulative mechanisms of diapause.

Material and methods

Material was collected in a small excavation, situated about 1 km from the coast and 3 m above sea level. On its calcareous sandstone floor, meteoric water collects in a pool of about 400 m^2 surface, rich in immersed and emerging vegetation. In summer, the pool may or may not dry up, depending on the weather conditions. It has been reported dry for some years, but this did occur neither in 1983 (when advance instars of permanent water species were found in autumn), nor in 1984 (cf. Tab. 1). However, it did dry up in 1985, but remained flooded throughout the summer of 1986.

Dragonflies had been sampled for about one year: the adults with a standard entomological net, and the larvae with a dip-net (aperture 20x20 cm, mesh 1 mm). The width of the larval heads was measured by means of an ocular micrometer and a stereomicroscope, with an approximation smaller than 0.1 mm. Water temperature and salinity (always zero) were measured with an I.S.I. salinimeter (type 33).

Results

In Table I are shown the temperature, the water level and the species collected in each sample. The presence of water throughout the year does not hinder the development of the temporary water colonizers (WIGGINS et al., 1980). In fact, as far as the abundance of individuals is concerned, the pool community is dominated by such species.

In spring 1984, the development of *L. barbarus* and *L. virens* was normal (cf. Fig. 1). In October 1984, there were a very great number of small *Lestes* and *Sympetrum* larvae, none of which could be specifically identified. As far as *Lestes* is concerned, *L. viridis* and *L. macrostigma* could be excluded on the ground of the racket-shaped mask, peculiar to our material, though both species do occur elsewhere in "Le Cesine" (CARCHINI et al., 1986). Likewise, for biogeographic reasons, *L. sponsa* and *L. dryas* could also be excluded (cf. CARCHINI et al., 1985; CARCHINI & ROTA, 1987).

Discussion

With reference to the occurrence of very young *Sympetrum* larvae in October 1984, it should be mentioned that in the "Le Cesine" area the genus is represented by 3 species, viz. *S. striolatum*, *S. sanguineum* and *S. meridionale* (CARCHINI et al., 1986). The adults of the first of these were abundant at the excavation and elsewhere in the area, therefore it cannot be excluded that the October larvae are referable to *S. striolatum*. Since an embryonal diapause is lacking in this species (ROBERT, 1958).

Table I — Review of sampling data

Date	Water temperature	Water level (m)	Material collected
17-XI-83	12° C	1	*Brachytron pratense*, 4 larvae *Anax imperator*, 1 larva *Libellula fulva*, 1 larva *Orthetrum coerulescens*, 2 larvae *Crocothemis erythraea*, 12 larvae *Trithemis annulata*, 7 larvae
26-XII-83	11° C	1	—
29-II-84	12.8° C	1	*Lestes barbarus*, 40 larvae *Sympetrum sanguineum*, 2 larvae
18-III-84	12° C	1	*Lestes barbarus*, 41 larvae
11-IV-84	15° C	1	*Lestes barbarus*, 35 larvae *Lestes virens*, 3 larvae *Aeshna affinis*, 1 larva *Sympetrum striolatum*, 1 larva *Sympetrum sanguineum*, 1 larva
25-V-84	20° C	1	*Lestes barbarus*, 1 larva, numerous young imagoes *Lestes virens*, 9 larvae *Sympetrum sanguineum*, 1 larva
22-VIII-84	—	0.5	—
14-X-84	18.5° C	0.5	*Lestes virens*, 5 tandems, 1 ♂ *Lestes* sp., 12 larvae *Brachytron pratense*, 1 larva *Sympetrum striolatum*, 1 tandem, 1 ♂ *Sympetrum* sp., 20 larvae

The presence of *Lestes* larvae in autumn appears enigmatic. These may belong either to *L. barbarus* and *L. virens*, or to one of them. Both species are common in the astatic habitats of southern Italy, and their development has been studied in the coastal environments that are similar to that of "Le Cesine". Their annual cycle is characterized by oviposition in August--October, a long embryonal diapause, hatching in February-March, and by emergence in May--June (CARCHINI & NICOLAI, 1984). Consequently, the occurrence of their larvae in autumn is completely anomalous.

Few other autumn records of *Lestes* larvae are reported in the literature. VALTONEN (1982), studying a *L. sponsa* population in Finland, captured ultimate instar larvae at the end of September. He ascribed this phenomenon to the exceptional weather conditions in the summer of 1981, when an unusually long spell of rainy weather occurred during the period that is critical for the emergence. The latter was delayed, and the larval phase prolonged until the end of summer. A similar explanation is to be excluded for the population of "Le Cesine". Both *L. barbarus* and *L. virens* regularly completed their development in spring 1984. Moreover, the small size of the larvae collected in October indicates recent hatching.

FISCHER (1964) found the earliest *Lestes* instars in September, in a pond that was completely dry until August. She concluded that the drought delayed the hatching until about a year after oviposition. Again, our case differs from Fischer's evidence. Our pool was surely flooded from November 1983 to August 1984, thus allowing the normal development of the *barbarus* and *virens* populations (cf. Fig. 1).

The larvae we captured in October must have come from eggs laid in the summer of the same year. It is, therefore, a matter of anticipated hatching of eggs that were not subject to the normal period of diapause rather than a postponed hatching of eggs that completed diapause.

The regulation of diapause in *Lestes* has been studied in many species and was proved to be controlled by temperature, photoperiod and immersion in water (CORBET, 1962; WIGGINS et al., 1980). While data are missing for *L.*

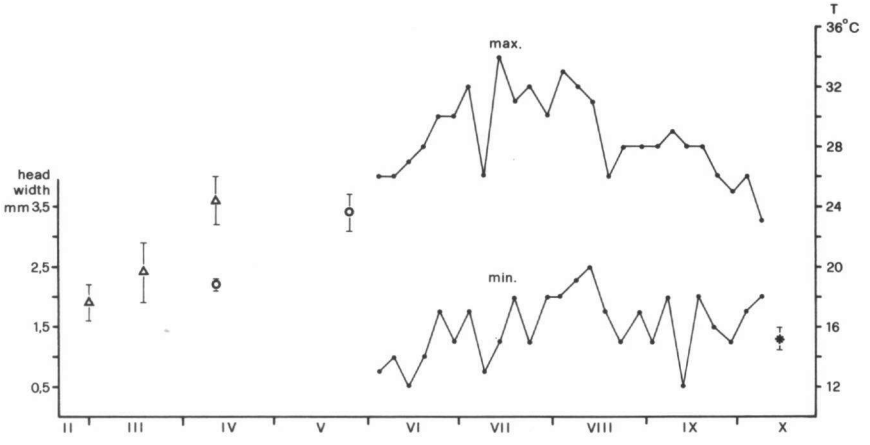

Fig. 1. Size of *Lestes* larvae and air temperatures in the pond area during 1984. For each larval sample the mean value is given with a standard deviation range. — (Triangles: *L. barbarus;* — circles: *L. virens;* — asterisk: *Lestes* sp.).

virens, a laboratory research has been carried out on *L. barbarus* by AGUESSE (1968). He states that diapause always occurs in this species and is interrupted after a period of cooling, lasting some weeks, below a +10° C threshold temperature. This pattern is identical with that described by CORBET (1956) for *L. sponsa.*

A different mechanism of diapause interruption or complete elimination is recorded by LOIBL (1956) in *L. sponsa* and *L. barbarus:* eggs laid between early July and early September, collected in nature and kept on a filter paper dipped in 20° C water, hatched between mid October and the beginning of December *(L. barbarus)* and between mid October and early February *(L. sponsa).* She comes to the conclusion that diapause does not necessarily occur and embryonal development is controlled by temperature. Premature hatching, due to immersion of the eggs in diapause in water, was evidenced in *L. dryas, L. unguiculatus, L. forcipatus* and in *L. congener* by NEEDHAM (1903) and LAPLANTE (1975). The latter also obtained even more premature hatchings from the last 3 species, by dipping newly-laid eggs into water at 20-25° C. The above-mentioned species lay eggs in dry stems of plants and the consequences of this have already been discussed by CORBET (1962), who supposes that in these and in other temperate species development is completed before the end of October, after which eggs are ready to hatch as soon as they are immersed in water of an adequate temperature.

Conclusions

In the light of the above, the occurrence of young *Lestes* larvae in autumn appears to be a case of interruption of embryonal diapause. This might have been caused by an adequate period of cold. Nevertheless, an analysis of the air temperatures recorded around the Reserve "Le Cesine" shows that the mean minimal temperature of five consecutive days was always higher than 10° C (Fig. 1). Since the recorded temperatures refer to the air, while the thermic ranges are generally narrower in water, one can assume that the temperatures in the pool did not drop below 10° C. The cooling of the eggs, therefore was insufficient for the interruption of diapause in *L. barbarus.* The other reason for an advanced hatching might be the immersion of the eggs in relatively warm water. In fact, even if the pools are full of water, *L. barbarus* and *L. virens* lay eggs on emerging plants or on those growing on a completely dry ground around the pond (UTZERI et al., 1987). In this way the eggs remain dry till the rise of the water table; in

southern Italy this happens after the autumn rains in October and November, followed by a fall in temperature. Around the Reserve "Le Cesine", however, in 1984 there were 12 rainy days in August, 8 in September and 6 in October, against the respective means (1946--1970), of 2.3, 4.5 and 7.1 (source: Cartello Metereologico A.M., stations of Lecce and Bari). We think that the unusual summer rains have increased the water table of the pool in such a way as to submerge the eggs. Immersed in relatively warm water (cf. Fig. 1), the eggs have developed precociously to the usual pattern as recorded in nature by NEEDHAM (1903) and LAPLANTE (1975) and in the laboratory by LOIBL (1956).

Our observations show that the regulative mechanisms of diapause in *L. virens* and/or *L. barbarus*, depending on the temperature and the presence of water, may be subject to "errors" when weather conditions deviate from the usual pattern. We do not know whether larvae hatched in October could complete the life cycle and emerge, nor whether the premature hatching concerned both species or one only. The fact is that they colonize a good portion of the temporary habitats in Italy. An important share in their success is certainly to be ascribed also to their adaptive oviposition behaviour.

References — AGUESSE, P.A., 1986, *Les Odonates de l'Europe occidentale, du nord de l'Afrique et des Iles Atlantiques*, Masson, Paris; — CARCHINI, G. & P. NICOLAI, 1984, *Odonatologica* 13(3): 461-466; — CARCHINI, G. & E. ROTA, 1986, *Biogeografia* (N.S.) 10: 629-684; —CARCHINI, G., E. ROTA, M. BOLLINO & C. UTZERI, 1986, *Fragm. entomol.* 18(2): 253-276; —CARCHINI, G., E. ROTA & C. UTZERI, 1985, *Fragm. entomol.* 18(1): 91-103; — CORBET, P.S., 1956, *Proc. R. ent. Soc. Lond.* (A) 31: 45-48; — 1962, *A biology of dragonflies*, Witherby, London; — FISCHER, Z., 1964, *Pol. Archwum Hidrobiol.* 12(3): 349-382; — LAPLANTE, J.-P., 1975, *Naturaliste can.* 102(3): 279-292; — LOIBL, E., 1958, *Z. Tierpsychol.* 15: 54-81; — NEEDHAM, J.C., 1903, *N. Y. St. Bull.* 68: 218-279; — ROBERT, P.A., 1958, *Les libellules (Odonates)*, Delachaux & Niestlé, Neuchâtel; — UTZERI, C., E. FALCHETTI & R. RAFFI, 1987, *Fragm. entomol.* 20(1): 1-22; — VALTONEN, P., 1982, *Notul. entomol.* 62: 151; — WIGGINS, G.B., R.J. MACKAY & I.M. SMITH, 1980, *Arch. Hydrobiol.* (Suppl.) 58(1/2): 97-206.

Received March 17, 1987