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SHORT COMMUNICATIONS

CHEMICO-PHYSICAL DATA ON THE HABITATS OF RHEOPHILE ODONATA FROM CENTRAL ITALY

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Odon. larvae collected in the Mignone River, central Italy are reported in correlation with the chemico-physical features of the sites sampled. All spp. found are shown to tolerate moderate natural mineralization of water in the absence of man-originated pollution. Results are compared with data for the nearby Topino River, which is more polluted, and with some other streams. *Calopteryx splendens* appears to be of little utility as a biological indicator, but other odon. spp. may be useful.

INTRODUCTION

Odonate larvae are relatively abundant normal components of rheophile macrobenthonic communities (HYNES, 1970). Despite this fact, relatively few investigations have been conducted into the chemico-physical characteristics of the aquatic habitats concerned. ROBACK (1974) published a review of this type of data on natural populations of only 67 North American species. No similar review exists for Europe, although an assessment of the overall knowledge in this field may be obtained from SLADECEK's work (1973), which considers 13 species.

Despite this dearth of observations, which are fewer than those for other groups of aquatic insects, odonates are generally considered as being of little value as biological indicators (ROBACK, 1974). This conviction has influenced studies on biological indices for the assessment of the quality of running waters. Odonates are not even considered in the "Biotic Index" (WOODIWISS, 1964) or the "Biotic Score" (CHANDLER, 1970). In the "Indices Biotiques" (VERNEAUX & TUFFERY, 1967), "Indices de Qualité Biologique Globale" (VERNEAUX et al., 1976) and "Extended Biotic Index" (WOODIWISS, 1979), odonates do not appear in the assessment tables, but are only included in calculations on the number of taxa, at the genus level. CHUTTER (1972), in his "Biotic Index", considers odonates at the genus level and always assigns them a minimum quality rating, i.e. zero. Lastly, "Quality Rating" (CLABBY & BOWMAN, 1979) considers odonates only at an order level, assigning them to Group C, i.e. relatively tolerant forms.

In contrast with the only slight importance afforded odonates by the aforementioned authors, some works show that rheophile dragonflies are potentially valuable as environmental indices even in polluted conditions. GENTRY et al. (1975), in a study of the Anisoptera of the Savannah River Plant area, found only 7 species (all Libellulidae) in those bodies of water subject to hot discharges from the nearby nuclear power plants. Conversely, in other water bodies that were not affected by heat pollution, these 7 species, plus one more, were found in addition to 15 species from other families (Gomphidae, Aeshnidae, Macromiidae, Corduliidae). CARLE (1979), studying American species, and WATSON (1982) Australian species, sustain that odonate larvae are reliable biological indicators. WESTFALL (1983) reports that *Argia* larvae are currently being used as pollution indicators in Florida rivers; WASSCHER (1983) considers *Calopteryx* sp., *Somatochlora metallica* and *Sympecma fusca* as possible indicators of environmental variations, whereas MOORE (1983) believes that *Ischnura elegans* and *Platycnemis pennipes* are sensitive to a number of pollutants.

The use of odonate species in the assessment of river pollution seems to be particularly useful in the study of flatland rivers (cf. MOLLER-PILLOT, 1971; BELTMAN & BLEUTEN, 1978). Investigations of these rivers are of considerable practical interest because they are the ones most frequently hit by urban and industrial pollution. Lastly, dragonflies have greater importance as biological indicators in the more recent biological system of assessing water quality proposed by VERNEAUX et al. (1982). In his system odonate families are included among the 38 taxa considered as indicators and the order also appears in this assessment table.

Because the ecological tolerances of European rheophile dragonfly larvae are not yet well known, the objective of this paper is to report data for species that have not yet been investigated from this point of view, at least not so in Mediterranean Europe.

The field work was conducted during two projects: one designed to assess the quality of water from the Mignone River using biological methods, and the other to obtain a hydrogeological study of the same river.

STUDY AREA

The Mignone River is formed by the confluence of several streams at an approximate altitude of 350 m above sea level, and pours into the Tyrrhenian Sea about 80 km North of Rome, after a course of some 60 km. Flow rates have summer lows and winter highs of 0.13 m^3/sec and 8.70 m^3/sec, respectively. The hydrographic basin covers some 480 km^2 and includes volcanic and calcareous rocks and several mineral and thermal springs (CATTENA, 1983). Climate and vegetation are mediterranean; inland zones are cooler and more humid than the coastal areas and have beech woods at low altitudes. Human activity in the entire basin is relatively low and a suggestion has been advanced to use the area as a nature reserve (CONTOLI et al., 1980).

METHODS

Six sampling stations were set up at more or less regularly spaced intervals along the river starting at an altitude of 297 m and going down to 4 m along a 46-km stretch. Sampling was conducted monthly from February 1980 to February 1981, and 56 joint chemico-physical and biological samplings were obtained.

Macrobenthos was sampled at each station in two standard ways: (a) three replicas with a 28 x 37.5 cm sampling area and 0.4 x 0.5 mm mesh Surber nets, and (b) pulling a hand net of 40-cm base and 0.4 x 0.5 mm mesh across the river for 3 minutes. The material collected was fixed on the spot, then sorted in the lab and identified. Additional samplings to obtain more odonates were performed with a hand net in an approximately 15-m stretch of river without any time limitations.

The methods used to analyze the water were those in A.P.H.A. et al. (1971). Temperature, pH, dissolved oxygen, BOD, COD, alkalinity, conductivity, hardness, flow speed, and concentrations of Na^+, K^+, Ca^{++}, Mg^{++}, NH_4^+, NO_2, NO_3, Cl, and SO_4 were measured. Further details on the analytical methods adopted may be obtained from PERTICONE (1982).

RESULTS

The following 19 species were collected: *Calopteryx haemorrhoidalis* (Vander L.), *C. virgo* (L.), *C. splendens* (Harr.), *Lestes viridis* (Vander L.), *Platycnemis pennipes* (Pall.), *Pyrrosoma nymphula* (Sulz.), *Ischnura elegans* (Vander L.), *Cercion lindeni* (Sel.), *Coenagrion caerulescens* (Fonsc.), *Boyeria irene* (Fonsc.), *Aeshna cyanea* (Müll.), *Gomphus vulgatissimus* (L.), *Onychogomphus forcipatus* (Vander L.), *O. uncatus* (Charp.), *Cordulegaster boltoni* (Don.). *Oxygastra curtisi* (Dale), *Orthetrum coerulescens* (Fabr.), *O. brunneum* (Fonsc.), and *O. cancellatum* (L.).

As expected, the three collection methods were of different efficiencies; 6 species (*P. pennipes, C. lindeni, C. caerulescens, I. elegans, O. forcipatus* and *O. brunneum*) were collected with the Surber nets, 8 species with the 3-minute hand nettings (*C. splendens, P. pennipes, C. lindeni, C. caerulescens, O. forcipatus, O. uncatus, G. vulgatissimus* and *O. brunneum*) and all 19 species were collected as a result of the supplementary samplings.

Chemico-physical conditions at the moment the larvae were collected (with any of the 3 methods used) are reported in Table I. *A. cyanea* does not appear in the table because only two specimens were collected during a sampling that was not coupled with a concomitant water analysis. The data vary considerably from species to species; this is mostly due to the different sample sizes of the various species. For the 11 species of which less than 20 specimens were collected,

Table I

Variation ranges of chemico-physical parameters of water (N: number of individuals collected; — T: temperature in ° C; — C.V.: current velocity in cm/s; — Conductivity, in uS (18° C); — Hardness in mg/l of $CaCO_3$; — DO: dissolved oxygen in mg/l; — BOD: biological oxygen demand (5 days) in mg/l of O_2; — COD: chemical oxygen demand in mg/l of O_2; — Alkalinity, in mg/l of HCO_3^-. All ion concentrations are in mg/l except pH. The number of records (i.e. cases in which one or more individuals were found) is given in parentheses)

N	Species	T	C.V.	Conductivity	Hardness	pH	DO	BOD	COD	Alkalinity
13	*C. haemorrhoidalis*	5.5/23.5(6)	17/40/(2)	315/577(6)	160/275(4)	6.0/7.4(5)	8.5/13.4(5)	0.9/2.3(5)	3.0/5.7(4)	198/268(4)
17	*C. virgo*	14.5/20.0(3)	— —	315(1)	160(1)	6.4(1)	8.5(1)	0.9(1)	5.7(1)	198(1)
101	*C. splendens*	4.5/28.0(17)	8/62(8)	315/561(15)	160/275(8)	6.0/8.2(12)	8.0/13.4(10)	0.8/4.9(10)	4.3/5.7(5)	190/271(8)
62	*L. viridis*	16.8/28.0(6)	13/48(4)	478/563(15)	268/275(2)	6.5/7.4(2)	9.3/9.5(3)	0.8/1.4(3)	4.3/5.8(3)	247/281(2)
896	*P. pennipes*	1.0/28.0(17)	1/62(25)	315/677(27)	160/330(17)	6.0/8.5(20)	7.8/13.9(18)	0.7/4.9(19)	0.4/5.8(13)	198/305(17)
9	*P. nymphula*	6.0/16.2(5)	8/62(4)	402/566(5)	227/330(4)	6.4/8.5(5)	8.0/11.5(4)	0.8/4.9(4)	2.0/5.3(3)	201/268(4)
19	*I. elegans*	6.0/24.0(7)	1/72(7)	501/636(6)	263/330(4)	6.7/8.5(5)	7.9/12.9(3)	0.7/2.3(4)	2.0/3.9(2)	218/270(4)
511	*C. lindeni*	4.5/28.0(24)	1/62(20)	351/677(22)	227/330(12)	6.0/8.5(16)	7.8/13.4(15)	0.6/4.9(17)	0.4/5.3(11)	198/305(12)
4	*C. caerulescens*	6.0/23.5(5)	11/72(5)	501/677(5)	259/330(3)	6.7/8.5(4)	9.3/12.9(3)	1.0/2.3(3)	2.0/3.6(2)	218/268(3)
8	*B. irene*	5.5/20.0(2)	— —	351(1)	— —	6.0(1)	13.4(1)	2.0(1)	— —	— —
64	*G. vulgatissimus*	4.5/27.0(16)	8/62(12)	315/636(14)	159/330(9)	6.4/8.5(11)	8.0/12.4(9)	0.6/4.9(9)	0.4/5.8(6)	198/281(9)
123	*O. forcipatus*	4.5/28.0(30)	8/72(27)	402/665(29)	223/330(18)	6.5/8.5(22)	7.6/12.9(20)	0.2/4.9(20)	0.3/5.8(15)	198/281(18)
6	*O. uncatus*	4.5/20.0(4)	13/57(3)	362/631(4)	196/295(3)	7.6/8.0(3)	7.6/11.1(3)	0.4/1.9(3)	0.8/5.2(3)	195/265(3)
13	*C. boltoni*	7.5/21.0(3)	8/62(2)	402/461(2)	254(1)	6.5/7.5(2)	8.0(1)	4.9(1)	— —	248(1)
50	*O. curtisi*	4.5/28.0(12)	1/48(8)	315/642(11)	160/295(8)	6.4/8.2(9)	8.5/12.4(9)	0.8/2.1(9)	0.4/5.8(7)	198/305(8)
3	*O. coerulescens*	5.0/14.5(2)	31(1)	315/542(2)	160/281(2)	6.4/8.5(2)	8.5/10.5(2)	0.6/0.9(2)	1.3/5.7(2)	198(2)
11	*O. brunneum*	6.0/24.0(8)	1/62(8)	402/566(6)	250/330(4)	6.5/8.5(5)	7.6/11.5(4)	0.8/4.9(4)	2.0/5.2(2)	201/268(4)
2	*O. cancellatum*	18.0/20.3(2)	1/15(2)	642/644(2)	295/299(2)	7.8/8.2(2)	7.8/9.7(2)	1.8/2.0(2)	3.0/4.9(2)	262/305(2)

N	Species	Na^+	K^+	Ca^{++}	Mg^{++}	NH_4^+	NO_2^-	NO_3^-	Cl^-	SO_4^{--}
13	*C. haemorrhoidalis*	15/30(4)	6/10(10)	28/75(4)	8/24(4)	0.00/0.14(4)	traces(4)	3/5(4)	42/54(4)	30/91(4)
17	*C. virgo*	15(1)	6(1)	75(1)	24(1)	0.00(1)	traces(1)	5(1)	42(1)	75(1)
101	*C. splendens*	15/23(8)	6/10(8)	28/81(8)	8/24(8)	0.00/0.08(5)	traces(5)	4/13(5)	21/58(8)	15/90(8)
62	*L. viridis*	21/23(2)	7/9(2)	60/77(2)	8/12(2)	0.00/0.08(2)	traces(2)	4/5(2)	36/56(2)	75/90(2)
896	*P. pennipes*	15/35(17)	6/10(17)	28/92(17)	8/24(17)	0.00/0.14(15)	0/traces(15)	0/14(15)	28/69(17)	30/100(17)
9	*P. nymphula*	18/27(4)	7/10(4)	28/81(4)	8/12(4)	0.00/0.08(3)	traces(3)	4/14(3)	28/58(4)	35/37(4)
19	*I. elegans*	25/35(4)	7/8(4)	75/90(9)	12/14(4)	0.00/0.14(3)	0/traces(3)	0/14(3)	34/50(4)	35/100(4)
511	*C. lindeni*	18/35(13)	7/10(13)	28/92(13)	8/19(13)	0.00/0.14(11)	0/traces(11)	0/14(11)	28/69(12)	35/100(12)
4	*C. caerulescens*	22/30(3)	7/8(3)	68/86(3)	12/18(3)	traces/0.14(2)	traces(2)	3/14(2)	34/54(3)	30/72(3)
8	*B. irene*	— —	— —	— —	— —	— —	— —	— —	— —	— —
64	*G. vulgatissimus*	15/27(9)	6/9(9)	60/84(9)	8/24(9)	0.00/0.08(7)	0/traces(7)	4/14(7)	28/58(9)	35/90(9)
123	*O. forcipatus*	18/35(18)	7/9(18)	60/94(18)	8/19(18)	0.00/0.14(14)	0/traces(14)	0/21(14)	28/62(18)	30/100(18)
6	*O. uncatus*	23/35(3)	7/8(3)	62/94(3)	12/14(3)	0.00/traces(3)	0/traces(3)	0/21(3)	29/50(3)	42/100(3)
13	*C. boltoni*	23(1)	7(1)	74(1)	12(1)	— —	— —	— —	28(1)	36(1)
50	*O. curtisi*	15/28(8)	6/10(8)	28/92(8)	8/24(8)	0.00/0.08(7)	traces(7)	4/13(7)	28/58(8)	35/90(8)
3	*O. coerulescens*	15/25(2)	6/7(2)	75/76(2)	19/24(2)	0.00/traces(2)	traces(2)	5/7(2)	42/46(2)	75/78(2)
11	*O. brunneum*	18/28(4)	7/8(4)	74/94(4)	11/14(4)	0.00/0.08(3)	traces(3)	4/21(3)	28/58(4)	35/100(4)
2	*O. cancellatum*	28/35(2)	8/10(2)	78/92(2)	15/17(2)	0.00(2)	traces(2)	3/4(2)	40/69(2)	49/92(2)

the reported data are probably an underestimate of the ranges of environmental variations to which larvae are subjected in the Mignone River. For the remaining 7 species the estimate may be considered sufficiently realistic: the ranges reported in the table differ only slightly from one species to the next and are all very close to the ranges of absolute values recorded in the Mignone. An exception to this picture is that presented by *L. viridis*, which exhibits much smaller ranges. This is clearly a result of the brevity of its larval life which lasts only 3 months (in the Mignone: May — July). No chemico-physical parameter exhibits extreme values (sensu ROBACK, 1974), however, many of them are in the upper categories, which include those for polluted waters, according to the NISBET & VERNEAUX' (1970) classification. Parameters characterizing water mineralization have high values: this is due to the nature of the basin rocks and the presence of mineral springs (PERTICONE, 1982; CATTENA, 1983). Conversely, parameters typifying water pollution have low values and this agrees with the good quality of the water as ascertained using biotic methods (BAZZANTI et al., 1981; NICOLAI et al., 1982).

DISCUSSION

The results above show that the odonate larvae of the Mignone River tolerate fairly high temperatures and water mineralization similar to those in polluted rivers. The question remains whether similar tolerance levels are to be found in all populations of the species herein reported or whether this is a characteristic of southern populations, if not of the River Mignone populations alone.

Several recent works on the quality of running waters in Italy report chemico-physical analyses that could be correlated with odonate samplings. Unfortunately, odonate determinations are (mostly) at the genus rather than at the species level (cf. SPANÒ et al., 1976, 1978; CASELLATO et al., 1978; BODON et al., 1981), except for *C. splendens*, for which GIANOTTI et al. (1979) supplies data. They apply to River Topino populations (Central Italy) and report several parameter ranges, of which some are far wider than those for the River Mignone population (Topino ranges: pH, 7.3/8.8; DO, 0.9/13.8 mg/l; BOD, 1.5/15.5 mg/l; NH_4^+, 0/1.06 mg/l; NO_2^-, 0.01/0.07 mg/l). This is due to consistent urban and industrial pollution in the Topino. We may credit *C. splendens* with a considerable ecological adaptability. ZAHNER (1959) reported some parameter ranges for populations in southern Germany which are like those in the Mignone (Danube ranges: pH, 5.8/7.9; T, 12.3/24.0° C; DO, 6 mg/l). BROWN (1977) found *Calopteryx* (unfortunately identified only as "*Agrion:* Agriidae") to occur in drainage streams from English mines with extremely high concentrations of Zn and Cu.

We agree with SLADECEK (1973) who suggests that *C. splendens* is of little value as a biological indicator, but it would be wrong to consider all odonates alike. In fact, such a sweeping generalization is disproven by the comparison between the number of species found in the Mignone River and the Topino River, where *C. splendens* alone was gathered. Because sampling in the Topino was conducted using the 3-replica method with Surber nets for extensive sampling (24 monthly samplings at 15 stations distributed over 47 km of waterway from 632 to 175 m alt.), the difference in number of species gathered with the said method (6 for the Mignone, 1 for the Topino) would seem correlated with the pollution of the Topino. In conclusion, it is likely that once the ecology of individual odonate species is known, some will be found to be more, some less ecologically tolerant, thereby acquiring different values as biological indicators, like those currently ascribed to other, more thoroughly studied orders of aquatic insects.

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