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Ecologia. — *Further studies on the reproductive strategy of two demes of* Asellus aquaticus *(L.) (Crustacea Isopoda) from southern Italy.* Nota (*) di LUCIANA MIGLIORE (**), ENZO MARCHETTI (***) e FLORA VALENTINO (****), presentata dal socio G. MONTALENTI.

ABSTRACT. — Two demes of *Asellus aquaticus* (L.) (Crustacea Isopoda) from Southern Italy, living in two close but different habitats (a bight in a river and a pond) have been studied. The river gets water uninterruptedly; the pond gets rainwater, mainly in winter.

The analysis of secondary productivity, as a result of (i) mean number of juveniles born per female and (ii) duration of the embryonic development, has been performed for each deme over a one year period. It evidenced that productivity is different both in the *mean monthly input of juveniles* and in the *total annual* one.

The mean monthly input is different between the two demes which entrust to different physiological parameters the regulation of the reproductive strategy; that is, in the river population it depends on the duration of the embryonic development and in the pond population, on the number of juveniles per brood. The adaptive value is discussed.

KEY WORDS: *Asellus aquaticus*; Reproductive strategy; Local population; Deme.

RIASSUNTO. — *Altri studi sulla strategia riproduttiva di due demi di* Asellus aquaticus *(L.) (Crustacea, Isopoda) dell'Italia meridionale.* Sono stati studiati due demi di *Asellus aquaticus* (L.) (Crustacea Isopoda) che vivono in habitat molto vicini tra loro ma molto diversi: l'ansa di un fiume e una pozza. Il fiume riceve ininterrottamente acqua nel corso dell'anno mentre la pozza riceve solo acqua piovana, prevalentemente durante l'inverno.

L'analisi della produttività secondaria, come risultato di i) numero medio di *juveniles* prodotti per femmina e ii) durata media del periodo di sviluppo embrionale è stata effettuata per ciascun deme per un intero anno. È stato possibile mettere in evidenza che la produttività varia sia per il numero medio mensile di *juveniles* immessi nella popolazione, sia per il numero totale annuo.

Il numero medio mensile è diverso tra i due demi che affidano a differenti parametri la regolazione della strategia riproduttiva: nella popolazione dell fiume la regolazione è affidata alla durata dello sviluppo embrionale mentre nella popolazione della pozza essa dipende dal numero di *juveniles* prodotti per covata. Viene discusso il valore adattativo delle due strategie.

INTRODUCTION.

The environment operates on populations (*via* natural selection or phenotypical plasticity) producing a diversification of the reproductive strategy (Skadshein, 1984; Bucklin and Marcus, 1985; Vepsäläinen *et al.*, 1985). This diversification has been observed and studied in several species living in a wide geographical area, by analysing differences in physiological characters shown by the population (Vitagliano Tadini and Valentino, 1969; Gooch and Hetrick, 1979; Dingle *et al.*, 1980; Bouletreau-Merle *et al.*, 1982; Migliore *et al.*, 1982; Pamilo, 1983).

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The diversification allows a perfect superimposition of the biological cycle on the environmental one in every population (Stearns, 1977; Calow *et al.*, 1981; Brittain, 1983; Bucklin and Marcus, 1985; Vitagliano Tadini and Migliore, 1985).

The present work has been performed on two demes of *Asellus aquaticus* (L.) from southern Italy, one from a bight of the Sarno river (S. Valentino Torio, Naples) where the streamflow is slow, the other from an isolated pond a few metres distant from the bight. The bight gets a great quantity of water from three springs all year long-the lowest mean flow at the station we considered is 7.40 mc/s (D'Elia *et al.*, 1974).

The pond, deep enough and 4 m in diameter, has no direct connection with the river and its main water supply is from rain, extremely rare in summer. As a consequence, the hydric characteristics of the two habitats (steamflow, water volume, O_2 and salt concentration, pH, food, etc.) vary seasonally in a different way. Some parameters of the two habitats are reported in tab. I.

TABLE I. – *Physical parameters of the two habitats.*

Habitat	River		Pond	
	Winter	Summer	Winter	Summer
Water supply	Three springs	Three springs	Abundant rain (*)	Very scarce rain
Streamflow	9.8-10.7	6.4- 9.1	—	—
O_2 concentr.	10.0-12.2	7.1-10.8	8.6-10.0	5.5- 8.1
Temperature (°C)	5.8- 8.7	18.0-22.5	5.0-10.0	20.0-26.0
pH	7.2- 7.4	7.4- 7.6	7.0- 7.5	7.0- 7.5
Organic matter	Scarce	Present	Abundant	Present
References:	D'ELIA *et al.*, 1974. Present study		Present study	

(*) Sporadic river floods.

Preliminary data on the two demes have been previously published (Migliore and Vitagliano Tadini, 1984). The aim of this work has been to evaluate whether diversification in reproductive activity can be found even between two «local populations» or «demes» of *Asellus aquaticus* (L.), living in these two habitats close to each other but experiencing different environmental pressures. With this end in view the number of juveniles born per female and their speed of embryonic development (from fertilized eggs to the penultimate larval stage) has been examined to obtain the values of monthly mean production of juveniles and the total annual one.

MATERIAL AND METHODS.

Asellus aquaticus (L.) is a freshwater Isopod inhabiting the mesosaprobic-β waters of the entire paleoarctic continent. Several characters (longevity, increase in body size, diapause) differentiate populations in this wide area; these characters are strictly correlated to latitude and continentality of the regions in which the population lives

(Steele, 1961; Andersson, 1969; Vitagliano Tadini and Valentino, 1969; Chambers, 1977; Økland, 1977; Adcock, 1979; Migliore and Vitagliano Tadini, 1981; Migliore *et al.*, 1982; Vitagliano Tadini and Migliore, 1985).

Furthermore, this species shows a significant correlation between female body size and number of juveniles *per* brood (Migliore and Vitagliano Tadini, 1981; Vitagliano Tadini and Migliore, 1985) and a variation over the year of the percentage of reproducing females (Comba *et al.*, 1976; Migliore *et al.*, 1982) and of the mating frequency (Comba *et al.*, 1976).

The populations were sampled monthly; embryo-bearing females and pairs were isolated and bred one per glass bowl (10 cm in diam., 6 cm high). The bowls contained 200 ml of spring water and standard food (decaying leaves kept from nature). Control females were bred in bigger breeding bowls, under the same laboratory conditions.

All the females were bred in thermostatic chambers (18 ± 1 °C) at natural photoperiod (Rome latitude). Animals were observed every second day. (For further details on the breeding techniques see Tadini Vitagliano *et al.*, 1982.)

A total of 974 females and 38,670 juveniles was observed. Female mortality rate was 13% after 30 days breeding. Statistical analysis was performed on an Olivetti computer P654.

We determined the number of iuveniles born per female and the duration of the embryonic development in the maternal brood pouch.

RESULTS.

(i) *Juveline production.* The monthly number of juveniles produced per female (tab. II, fig. 1) is significantly different over the year in the two demes. The river population shows the lowest number of juveniles/female in January, soon followed by December and June. A unique maximum is not evident. The pond population shows a very low number of juveniles/female in August and October and a very high number in the period December-February. The comparison of the total annual juveniles production in the two demes evidences statistically significant differences; by analysing the trimestral productivity it results that the difference in the annual productivity is mainly due to the period December-February but also to September-November (tab. II).

(ii) *Duration of the embryonic development in the maternal brood pouch, in the laboratory* (18 °C, *natural photoperiod*). The time fertilized eggs take to complete embryonic development in the various month of the year varies significantly (fig. 2) only in the river population; in this deme the longest duration occurs in December, the shortest in June. The differences in the pond population, less marked, are not statistically significant. (fig. 2, tab. III).

It must be underlined that the number of individuals in the maternal brood pouch does not interfere with the duration of the embryonic development; in fact, to both high and low number of embryos corresponds a long time of development and *vice versa.*

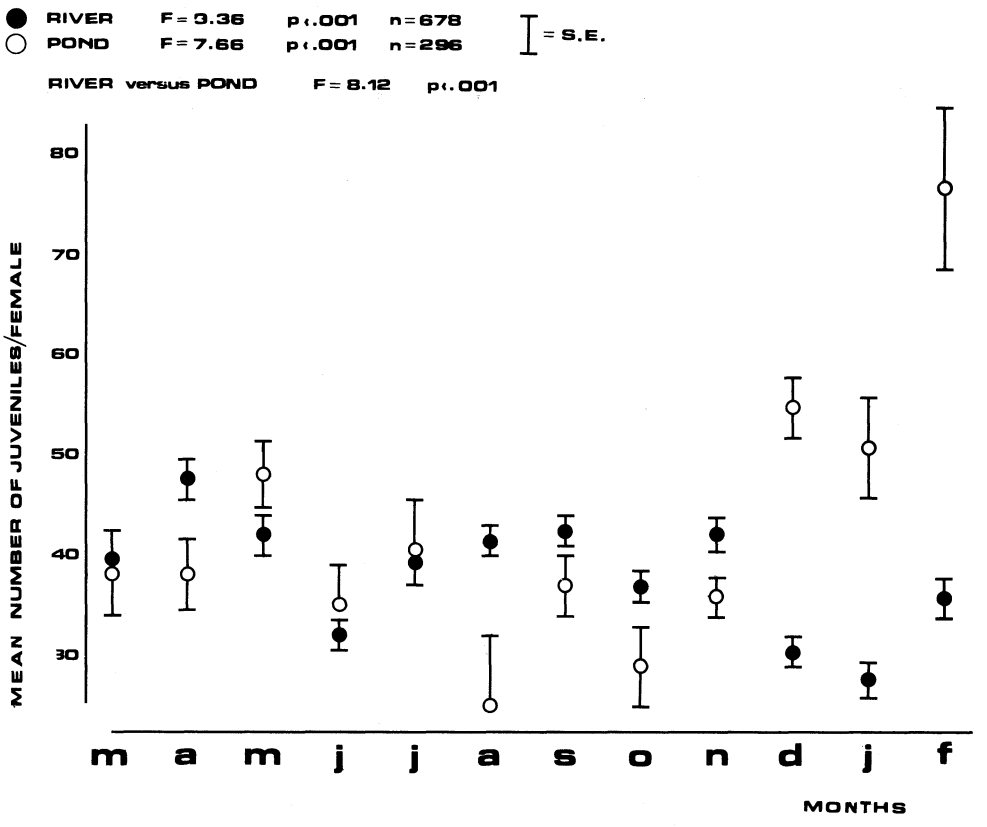

Fig. 1. – Mean number of juveniles born per female in the various months of the year.

TABLE II. – *Total annual trimestral production of juveniles in two demes of* Asellus aquaticus *(L.).*

	River		Pond		F	p
	Nr. ♀♀	Mean nr. juveniles	Nr. ♀♀	Mean nr. juveniles		
March April May	186	43.75	119	42.40	0.30	n.s.
June July August	157	37.64	49	35.24	0.88	n.s.
September October November	176	40.65	81	34.71	10.33	<0.001
December January February	159	31.45	47	62.42	126.65	<0.001
In the whole year	678	38.74	296	42.40	8.12	<0.001

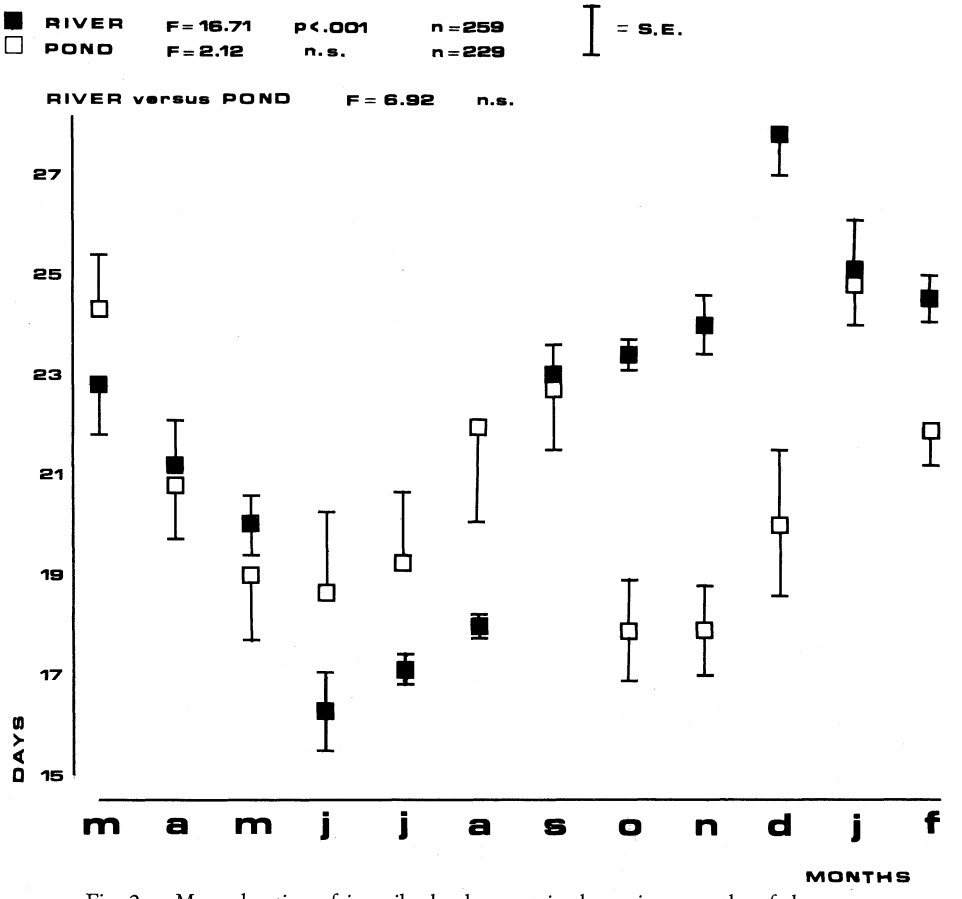

Fig. 2. – Mean duration of juvenile development in the various months of the year.

TABLE III. – *Mean time of development (in four trimesters) of* Asellus aquaticus *(L.) embryos coming from two demes.*

	River			Pond			F	p
	Nr. of embryo-bearing ♀♀	Nr. of embryos	Mean time of development	Nr. of embryo-bearing ♀♀	Nr. of embryos	Mean time of development		
March April May	85	3719	20.8	87	3689	20.0	0.48	n.s.
June July August	91	3425	19.1	39	1374	21.3	2.51	n.s.
September October November	40	1626	23.4	65	2256	21.2	4.08	n.s.
December January February	43	1353	25.6	42	2622	23.0	4.87	n.s.
In the whole year	259	10123	22.3	229	9941	21.4	6.92	n.s.

Discussion.

The species are adapted to the local climatic conditions in which they live. The perfect superimposition of biological and environmental cycles can be evidenced by studying *local populations* or *demes*, that is populations living in really close localities but occupying specific habitats (Morgan, 1980; Jansen, 1983; Bucklin and Marcus, 1985).

In *Asellus aquaticus* (L.) a clear divergence in body size and productivity (as number of juveniles produced) has been demonstrated in five U.K. local populations as a result of local variability of some environmental parameters (Aston and Milner, 1980). These five demes occupy different localities of the river Trent, not far one from the other, but subjected to different combinations of temperature and industrial pollution.

Our work demonstrates a clear differentiation of reproductive strategy in two demes of *Asellus aquaticus* living in Southern Italy. The differentiation involves both the mean monthly input of juveniles and the total annual one.

The mean monthly input depends on both the number of juveniles *per* female and on the time that fertilized eggs take to reach the penultimate larval stage (when they leave the maternal brood pouch and join the population).

Its value varies between the two demes in that

1) in the river population the regulation of the monthly input of juveniles depends on the duration of the embryonic development, the number of juveniles *per* brood not showing wide seasonal variations, whereas

2) in the pond population the regulation of the monthly input of juveniles mainly depends on the number of juveniles *per* brood, the duration of embryonic development not showing wide seasonal variations.

Hence, the two demes differentiate each other by entrusting to different physiological variables the regulation of the reproductive strategy. We hypothesize that *a*) in the river population the lengthening or shortening of the embryonic development can be regulated by photoperiod gradients (in that laboratory conditions are standard while photoperiod regime is the only variable) (Vitagliano Tadini and Valentino, 1969; Migliore *et al.*, 1982) and *b*) in the pond population the increase and decrease of the number of juveniles *per* brood can be regulated by food availability (Tadini Vitagliano *et al.*, 1984); however, the seasonal variation in reproductive effort is probably related to the monthly trends of environmental parameters such as water volume, O_2 concentration, pH, salt concentration and food availability.

Furthermore, the total annual input of juveniles is significantly higher in the pond population; this is probably related to the higher food availability in the pond were the absence of streamflow allows the leaves fallen in autunm to remain in the pond.

We cannot state at the moment whether the differences in the reproductive strategy are due to genetic selection of ecotypes (see Pamilo, 1983; Bucklin and Marcus, 1985) or to phenotypical plasticity of individuals (see Morgan, 1980).

In conclusion, in *Asellus aquaticus* (L.) the different environmental pressure operating on two demes living in specific habitats, very close to each other even though

different as regards the values and the seasonal trends of environmental parameters, produced a very clear diversification or the reproductive strategy.

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