Biological and Ecological features of *Procambarus clarkii* in Lake Trasimeno (Italy)

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1 Introduction

In 1999 *Procambarus clarkii* (Girard, 1852) was not reported for the Umbrian region (Central Italy) even if in the last 15 years fishermen of lake Trasimeno registered isolated cases of capture, considering this species as extremely rare. From the beginning of 2000 *P. clarkii* became object of professional fishery in the marshy zone of the lake called "La Valle" and was sold in the local fish markets (Dörr et al., 2001). The aim of this study was to get more information about the biological characteristics of *P. clarkii* and to investigate the reasons which are on the basis of its rapid expansion in Lake Trasimeno, giving a short description of the life cycle of this species.

2 Study area

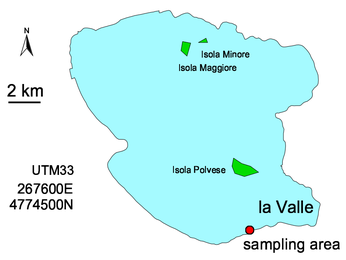

Fig. 1 - Lake Trasimeno

Lake Trasimeno, situated in the province of Perugia (Umbria, Central Italy), is the largest lake of the Italian peninsula ($126\ km^2$). This laminar lake is characterized by an average depth of $4.72\ m$ and a theoretical water return time of 24 years. Trasimeno is considered as pSIC and ZPS according to BIOITALY (Biotopes Inventory of Italy, reception Italian Directives of the UE Directives HABITAT 92/43).

3 Materials and Methods

Data collection started in October 2000 and finished in November 2001. *P. clarkii* was collected by a professional fisherman within 48 hours using 2 fyke nets in a depth of about $2\ m$. Specimens were transported to the laboratory to check body color (mature, immature), sex, moulting state (soft shell, hard shell) and, for females, reproductive state (internal egg stages and hatched juveniles). Each crayfish was characterized by total length (TL), carapace length (CL), chelae length (ChL), measured within $1\ mm$ accuracy, and weight (W) within $0.1\ g$.

4 Results

A total of 1169 crayfish was collected. In table 1 the descriptive statistics of the 4 morphometric variables are reported.

Tab. 1 - Descriptive statistics. L in cm, W in g

	female ♀			*male* ♂		
	min	*max*	*mean* ± *std*	*min*	*max*	*mean* ± *std*
TL	3.9	14.0	9.6 ± 1.8	4.3	13.0	9.1 ± 1.4
CL	1.9	7.3	4.9 ± 0.9	1.8	7.0	4.7 ± 0.8
ChL	0.8	5.8	3.0 ± 1.0	1.0	7.8	3.7 ± 1.2
W	1.1	74.6	25.8 ± 14.8	1.2	76.7	23.6 ± 12.5

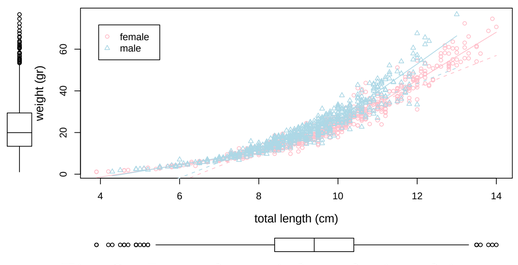

Fig. 2 - Length-weight relationships

The length-weight relationships for ♀ and ♂ were determined by regression analysis. For both sexes b values were greater than 3: $b_{♀} = 3.38$ ($R^2 = 0.97$) and $b_{♂} = 3.55$ ($R^2 = 0.95$)(Fig. 2).

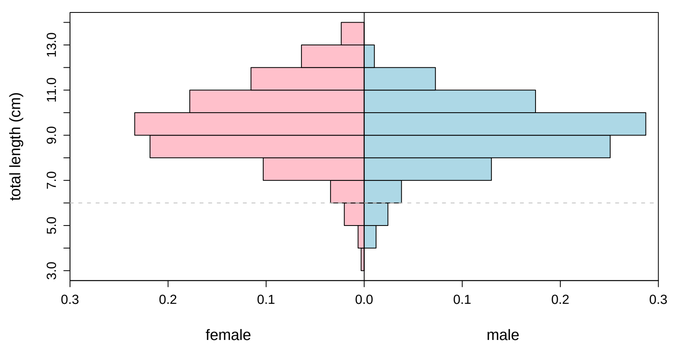

Fig. 3 - Length pyramid

Adult ♂ had TL between 5.7 and 13 cm, adult ♀ grew even larger, ranging from 5.9 to 14 cm. Differences between TL of ♂ and ♀ are statistically significant ($t - test = 5.1; p < 0.001$). Moreover only a little fraction of ♂ was greater than 11 cm (Fig. 3).

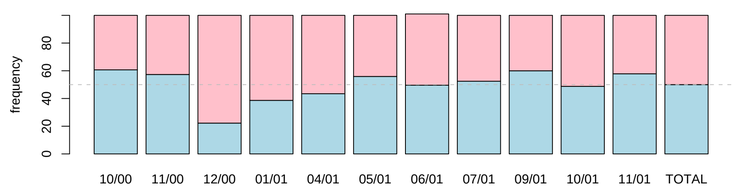

Fig. 4 - Fluctuations in the ratio of ♀ and ♂

Sex ratio for the whole population was 1:1. ♀ were more abundant in December 2000 and January 2001, period after hatching of the juveniles (Fig. 4). In February and March 2001 no specimen was captured; in those months water mean temperatures were 7.8 and 12.4°C respectively. The low temperature seems to inhibit the activity of this species in lake Trasimeno.

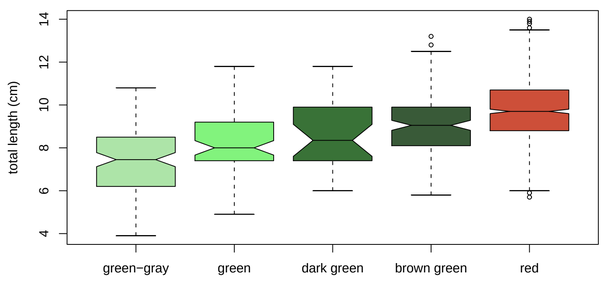

Fig. 5 - Crayfish body color

Analysis of TLs, separated by body color, showed significant differences (1-way ANOVA $F = 81.7; p < 0.001$) between red and all green classes. In particular green gradient seems to be correlated with the growth steps of crayfish (Beingesser and Copp, 1985)(Fig. 5). Moreover green juvenile ♂ had smaller chelae than the red adult ♂ (Huner and Barr, 1991).

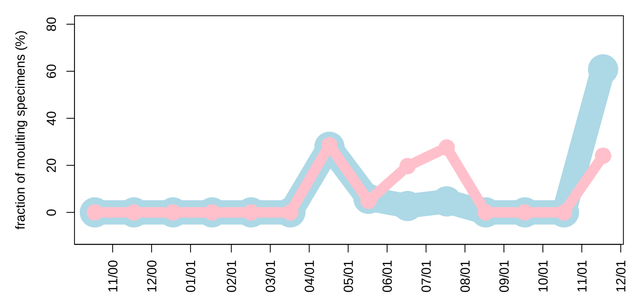

Fig. 6 - Fluctuation in moult for ♀ and ♂

With the increasing of water temperature in April 2001 (mean 14°C) moult started in both sexes but diminished in May. Only ♀ started to moult again in June and carried on until July. No moult was recorded for both sexes in August, September and October but moults started again in November 2001 (Fig. 6).

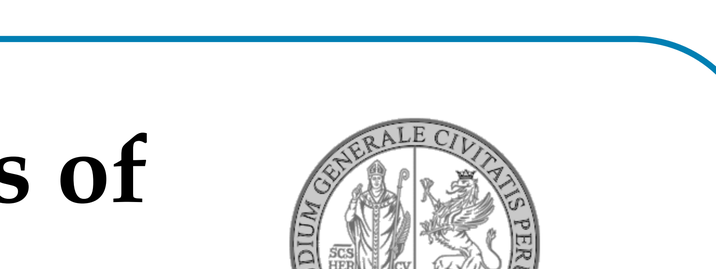

Fig. 7 - Internal egg stages during the sampling period

♀ were classified for sexual maturity analyzing the internal egg stages (*white: immature, yellow, orange and brown: mature*). In April all ovarian eggs were immature (*white*); maturation started in May and continued until July (*yellow*); from August to October ovarian eggs were mature (*brown*). ♀ with hatched juveniles were found in November and December (Fig. 7). In Summer, period of maximum ovarian egg maturation, water temperature ranged from 24.4 to 28.6°C, dissolved oxygen from 4.08 (41.7%) to 23.59 mg/l (185.4%), pH from 7.81 and 9.37 and conductibility from 1345.5 to 1434.0 $\mu S/cm$. Size of females at maturity: the smallest ♀ found with mature ovarian eggs measured 7.6 cm (TL). The smallest ♀ that carried eggs or juveniles had a size of 9.3 cm TL (4.7 CL). The reproductive period seems to be linked to temperature and lake level.

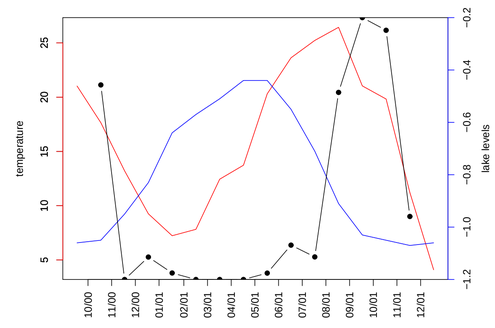

Fig. 8 - Temperature, lake levels and % of mature ♀

Ovarian eggs started maturation at water temperature of about 20°C and when the lake level began to decrease. By contrast ovarian egg maturation was reduced when temperature turned under 20°C and lake level was at the lowest value. The same reproductive situation was observed in Autumn 2000, the year before (Fig. 8).

5 Conclusion

In lake Trasimeno *P. clarkii* shows an allometric growth more in weight than in length ($b > 3$). In particular, green juveniles grew well and sexually mature females were large and abundant, and thus potential reproducers. This combination could explain the rapid expansion of *P. clarkii* in this shallow and mesotrophic lake. Both sexes had synchronized moults and this species started to reproduce when the water temperature increased and lake level decreased. Therefore the reproduction period in Trasimeno is Autumn. These results highlight that the crayfish population seems to be well acclimated and fits in with the natural cycle of the lake.

6 References

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