dents' holes. They were located at sight and caught by hand. Each individual was subsequently sexed and snout-vent length (SVL), tail length (TaL) and total length (TL) were measured with a dial calliper to the nearest 0.1 mm. Individual marking was applied by cutting a combination of one or two toes (Twitty, 1966; Donnelly *et al.*, 1994).

Sex was determined by analysis of external secondary sexual characters (SSC): adult males have a prominent, swollen, cloaca, and are more slender than females, which (especially when pregnant) are more corpulent than males. Furthermore, 'adults' were distinguished from 'juveniles', according to Klewen (1986) and Bonato (1998, unpubl. Thesis, Padova Univ.), with the latter group including individuals without evident external SSC, and usually with a total size smaller than 90 mm.

Fecundity and offspring parameters

Apparently-non-gravid females were indicated as 'non-pregnant females', while evidently-gravid females, probably at a late stage of gestation, were named 'pregnant females'. Pregnancy was established by gentle palpation of the females' belly: the presence of intrauterine larvae at the end of their development can usually be detected with this method, which has already been applied to *S. lanzai* (Andreone *et al.*, 1996, 1999a, b).

To obtain data about the number of newborns per female and to test the efficacy of belly pressing, 16 females were kept in captivity; these were judged as pregnant in the field, and captured (in the period 22-29 July 1996) at a locality situated approximately 1500 m from the study site and at the same altitude. They were subsequently maintained in terraria, each one being 40 × 40 cm and housing a single female; these were stored in the garden of the private house of one of us (DC). The terraria were provided with an articulated system of refuges which gave the salamanders the possibility to hide during the cold season. The ambient temperature of the terraria fell well under 0° C during the winter, and in fact the locality used for housing them (L'Aquila, Central Italy) is covered in snow for long periods from November to March.

Salamanders were measured and fed *ad libitum* with several preys, such as earthworms, caterpillars, slugs and larvae of different insects. Water was vaporized to guarantee the right degree of humidity. When salamanderlets were born, they were measured for TL and SVL. Post-partum females were then kept in captivity for a subsequent 15-day period to check for a possible delayed parturition, and were released later at the place of capture together with their newborns.

Data analysis

Data were analysed with the statistical software package STATISTICA, with alpha set at 5%, applying parametric and non-parametric tests. Two population ratios were estimated: the operational sex ratio (SR = no. of males : no. of females), and juvenile ratio (JR = no. of juveniles : no. of adults).

RESULTS

Population structure

In the overall study period, 148 salamanders were captured and marked. Males accounted for 51.7% of the adult population, and females for 48.3 %. Throughout the eight capture occasions the SR shifted from 0.13 of the first day (with eight females and one male) to the final 1.07 ratio, with a total of 61 males and 57 females (Fig. 1). These numbers are not different from the expected 1:1 ratio (χ^2 = 0.076, P > 0.05).

The ratio between juveniles and adults was more regular (Fig. 2): JR passed from 0.22 at the beginning of the study, to 0.27 at the sixth day, and to a final value of 0.25. The overall adult population was constituted by 118 animals, while juveniles were 30, thus accounting for 20.3% of the number marked.

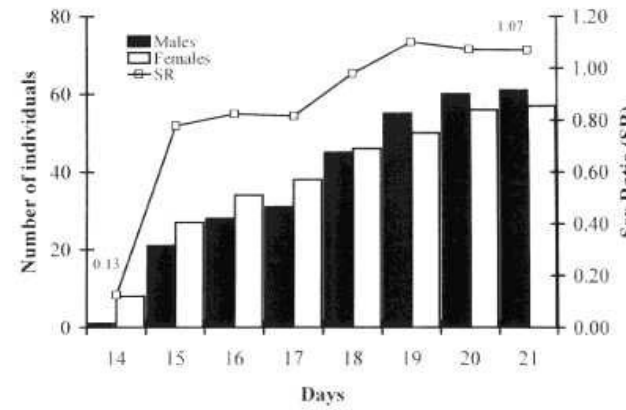

Fig. 1 - Day-by-day secondary sex-ratio variations in the studied *Salamandra a. atra* population at Sella Nevea (Tarvisio, NE Italy) from the beginning until the end of the study period (14-21 July 1996).

Body size and sexual dimorphism

Male TL ranged from 87.0 to 140.0 mm ($\bar{x}$ ± SD: 117.3 ± 13.1 mm), and female TL averaged 117.9 ± 11.8 mm (91.0-143.0 mm). Snout-vent length was 74.9 ± 7.5 mm in males and 76.0 ± 7.7 mm in females. Neither of these measurements proved to be significantly different between sexes (TL: t = -0.27, df = 127, P = 0.79; SVL: t = -0.81, df = 127, P = 0.42).

As expected, tail length was positively correlated to SVL both in males (r = 0.84, r^2 = 0.70, n = 61; ANOVA: $F_{1,59}$ = 140.85, P < 0.001) and females (r = 0.67, r^2 = 0.44, n = 57; ANOVA: $F_{1,55}$ = 43.68, P < 0.001). Although TaL/SVL ratio values were not significantly different between sexes (males = 0.92 ± 0.28; females= 0.88 ± 0.33; t = 0.11 P = 0.89), at the identical body

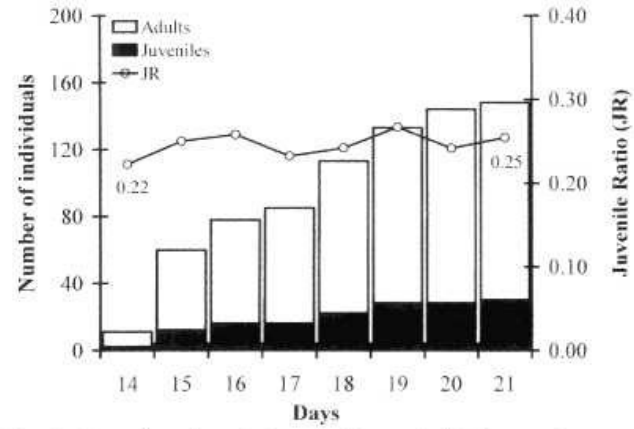

Fig. 2 - Juvenile ratio variations in the studied *Salamandra a. atra* population from the beginning until the end of the study period.