A MEAT-BASED DIET FOR REARING THE PREDATORY STINKBUGS
PODISUS MACULIVENTRIS AND PODISUS SAGITTA [HET. :
PENTATOMIDAE]

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A diet based on bovine meat was evaluated as an alternative food source for rearing the predatory bugs Podisus maculiventris (Say) and Podisus sagitta (Fabricius). Thus far, 7 and 5 continuous generations of the respective species have been reared on this diet. In comparison to rearing on larvae of the greater wax moth, Galleria mellonella (L.), however, nymphal development was prolonged with 15-40 % and adult weights were lower, reaching 72-82 % of the control weights. Fecundity of females reared on the meat diet was reduced to about 1/3-1/2 of that of the control, but egg weight and egg fertility were comparable with those in cultures fed live prey. Results obtained for laboratory rearing on this medium were generally better for P. maculiventris than for P. sagitta.

KEY-WORDS : Podisus maculiventris, Podisus sagitta, predatory bugs, artificial diet, mass-rearing.

The pentatomids Podisus maculiventris (Say) and Podisus sagitta (Fabricius) are polyphagous predators that mainly attack the larval forms of Lepidoptera and Coleoptera. They are reported to prey upon a number of economically important crop pests (Clausen, 1940; Warren & Wallis, 1971; McPherson, 1982). According to Torre-Bueno (1939), P. maculiventris is widely distributed throughout North America; P. sagitta is reported to occur from the southern United States into South America (Kirkaldy, 1909). Life history and predation characteristics of P. maculiventris have been studied extensively (Couturier, 1938; Mukerji & LeRoux, 1965; Warren & Wallis, 1971; Richman & Whitcomb, 1978; O'Neill, 1988). Only a few studies, however, have reported on the species P. sagitta : aspects of its laboratory rearing and biology have been documented by De Clercq et al. (1988) and De Clercq & Degheele (1990a, 1990b).

Although the rearing method using living prey can produce consecutive generations in the laboratory (Mukerji & LeRoux, 1965; De Clercq et al., 1988), the production of large numbers of predators may be hampered by occasional shortages of prey larvae. The development of an artificial diet that supports growth and reproduction could offer an alternative technique for the mass-rearing of these predatory insects. Prompted by the results presented by Cohen (1985) who succeeded in rearing the lygaeid bug Geocoris punctipes (Say) on an all-beef artificial diet, we decided to evaluate such a diet for rearing Podisus. This paper discusses the effects of feeding on a meat-based artificial diet on development and reproduction of P. maculiventris and P. sagitta in comparison to a control diet of living prey.
A laboratory colony of *P. sagitta* was established in 1982, using insects originally obtained from Surinam. A starter colony of *P. maculiventris* was obtained in 1989 from S. J. Yu (University of Florida, Gainesville, USA). Laboratory colonies of both species were cultured following the methods described by De Clercq et al. (1988).

The artificial diet was a modification of the meat-based diet described by Cohen (1985). This diet basically consisted of bovine meat and sucrose solution. In preliminary trials, the addition of ascorbic acid, Wesson's salt mixture and fresh hen's egg yolk was found to improve its nutritional value for the *Podisus* bugs (De Clercq & Degheele, unpublished results). In this way, the diet used for the experiments was composed of: 200 g beef liver, 200 g fatty ground beef (containing ca. 15 g fat per 100 g fresh weight), 24 ml sucrose solution (5 %), 1 g ascorbic acid, 2 g Wesson's salt mixture and 20 g fresh egg yolk.

All ingredients were first blended with a kitchen blender and then with a Virtis 23 blender until uniformly mixed. The paste was used fresh or stored deep-frozen (− 25 °C) in small packets wrapped in polyethylene and aluminium foil. Cylindrically shaped « artificial larvae », 2-4 cm long and 0.3 cm diameter, were produced by bringing thawed or fresh diet onto a stretched Parafilm M sheet and wrapping a single layer of the Parafilm around the diet paste.

For communal cultures of each *Podisus* species on artificial diet, nymphs and adults were housed in plastic containers (18 x 11 x 6 cm and 24 x 16 x 8 cm, respectively). Paper towels provided hiding places and oviposition sites. Artificial larvae were supplied in excess and daily replenished. Water was provided via a soaked paper plug fitted into a small plastic dish (2.5 cm diameter).

Development of the nymphal stages of *P. maculiventris* and *P. sagitta* was studied in every other generation reared on the meat diet. Four groups of 10 newly hatched first-instar nymphs were confined in disk-vented Petri dishes (9 x 1.5 cm); when reaching the 4th instar, nymphs were removed to larger Petri dishes (14 x 2 cm). Since first-instar nymphs are not predacious, they were only supplied with water. From the 2nd instar on, artificial larvae were provided in excess and were replaced daily. Moisture was provided as described above. Development was monitored twice daily; the presence of exuviae was used to determine molting. Survivorship in the nymphal stage and sex-ratios of the adults produced were recorded. Fresh weights of neonate adults were measured with a Sartorius B 120 S digital balance (+ 0.1 mg). Data obtained in the different generations reared on the artificial diet were compared with those of 40 nymphs fed *G. mellonella* larvae.

Reproduction was followed in consecutive generations of both *Podisus* species reared on the meat diet, but was studied in more detail only for adults of the 3rd generation (G3). Six pairs of adults (male : female) were confined singly in Petri dishes (14 x 2 cm) lined with filter paper. Daily, fresh artificial larvae were provided and water supply was checked. To avoid egg-cannibalism, eggs were removed upon laying. Preoviposition periods, fecundity and longevity of the female bugs reared on artificial medium were compared with those of adult pairs continuously reared on *G. mellonella* larvae.

Weights of 10 groups of 20 eggs, collected in communal cultures of each species, were measured (+ 0.1 mg) in consecutive generations on the meat diet. Fertility of the eggs was compared with that of eggs collected in cultures maintained on living prey.

All experiments were conducted in growth chambers at 23 ± 1 °C, 75 ± 5 % RH and a 16 : 8 (L : D) photoperiod.