## Pattern of adult eclosion during interspecific competition

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*Summary.* During interspecific competition, eggs of the same age, of 2 different species, experience different speeds of development. In each mixed culture there exist 2 different peaks of adult emergence. Here is a mechanism ensuring that the maximum number of one of the competing species emerges first followed by the other. The possible implications of this are discussed.

An important component of the environment of a population is the presence of other species with which it may compete/interact for the available resources of food and living space. The relative abundance of a species is dependent upon the kind and abundance of other species around it. Laboratory populations can be utilized as biological models to study the dynamics and the process of competition. Single species populations (pure cultures) and 2-species populations (mixed cultures) represent models of 2 levels of complexity. A project was undertaken to study the competitive interactions at these 2 levels in 3 sympatric species of *Drosophila*. The theme of the present report is to show the impact of interspecies competition on the pattern of adult eclosion.

*Materials and methods.* *Drosophila rajasekari*, *D. malerkotliana* and *D. nasuta nasuta*, which are distributed sympatrically in southern India[3,4], were used for the experiment. All 3 stocks originated from Mysore area (Karnataka, India). Eggs of these species were collected following the modified procedure of Delcour[5]. Eggs approximately 4-h-old were placed in vials (1″×3″) containing wheat cream agar medium seeded with yeast. In pure cultures, the eggs were distributed in 3 different densities, namely 100, 200 and 500 eggs per vial. At each density the total number of eggs placed was 1000. In the mixed cultures, the eggs of 2 species were placed simultaneously. In one set 100/100 eggs of each species and in another set 200/200 eggs of each species were placed. In each set, for each pair of species 5 vials were maintained. All these cultures were kept at 22 °C. After the onset of emergence the number of flies eclosed on each day were recorded. From this the mean rate of development and the viability were estimated.

*Results and discussion.* Figure 1 demonstrates the pattern of adult eclosion in the pure cultures of *D. rajasekari*. Similar trends were recorded in the pure cultures of *D. malerkotliana* and *D. n. nasuta*. On the other hand, the peak in the emergence of adults in the mixed cultures shows an interesting feature (figs 2–4). In almost all cases of interspecific competition, there exist 2 distinct peaks of adult eclosion, one for each competing species of the culture. These peaks are almost nonoverlapping, i.e., one succeeds the other. For instance, in the mixed cultures of *D. rajasekari*/*D. n. nasuta*, at 100/100 eggs density the peaks fall between 13–16 and 19–21 days respectively; similarly with 200/200 eggs the peaks are at 15–17 and 19–22 days respectively. Corresponding situations were encountered in the other mixed cultures. Table 1 summarises the statistical comparison of the rates of development of the 3 species under study. In the mixed cultures of *D. rajasekari*/*D. n. nasuta* and *D. rajasekari* and *D. malerkotliana*, *D. rajasekari* has a faster rate of development and most of its flies emerge ear-

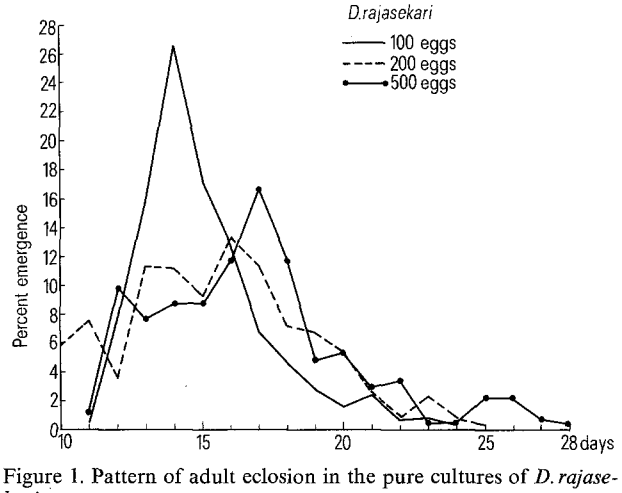


Figure 1. Pattern of adult eclosion in the pure cultures of *D. rajasekari*.

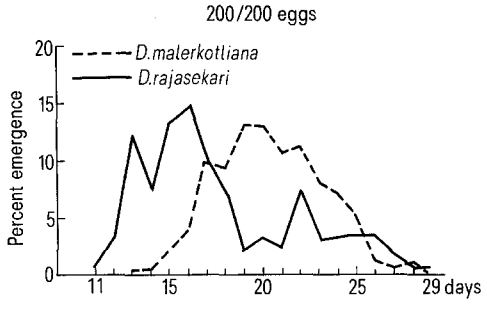


Figure 2. Pattern of adult eclosion in the mixed cultures of *D. rajasekari*/*D. malerkotliana*.

Table 1. Mean developmental time in days (mean ± SE) for the 3 species in their mixed cultures at the density of 200/200 eggs

| Rate of development of | During its interspecific competition with | | |
|---|---|---|---|
| | *D. rajasekari* | *D. malerkotliana* | *D. n. nasuta* |
| *D. rajasekari* | -- | 17.70 ± 0.19 | 14.81 ± 0.13 |
| *D. malerkotliana* | 20.34 ± 0.18 | -- | 15.64 ± 0.20 |
| *D. n. nasuta* | 23.01 ± 0.23 | 20.89 ± 0.14 | -- |

Table 2. Egg-to-adult viability of the 3 species in their mixed cultures at the density of 200/200 eggs for a total of 1000 eggs of each species

| Viability of | During its interspecific competition with | | |
|---|---|---|---|
| | *D. rajasekari* | *D. malerkotliana* | *D. n. nasuta* |
| *D. rajasekari* | -- | 445[b] | 300[d] |
| *D. malerkotliana* | 250[a] | -- | 354[f] |
| *D. n. nasuta* | 171[c] | 274[e] | -- |
| Comparisons: | $EX^2$ | df | p |
| a/b | 54.72 | 1 | < 0.001 |
| c/d | 35.34 | 1 | < 0.001 |
| e/f | 10.20 | 1 | < 0.005 |

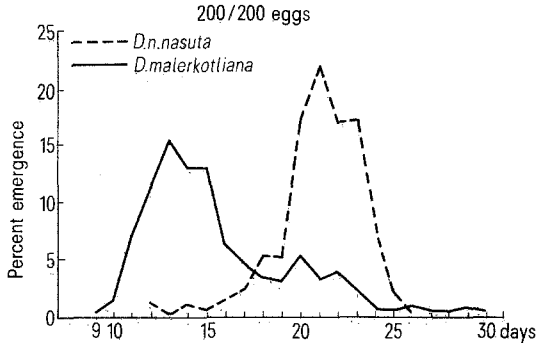


Figure 3. Pattern of adult eclosion in the mixed cultures of *D. malerkotliana*/*D. n. nasuta*.

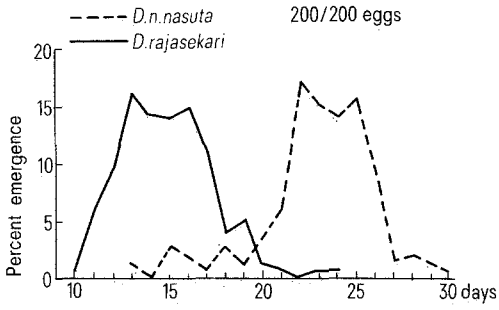


Figure 4. Pattern of adult eclosion in the mixed cultures of *D. rajasekari*/*D. n. nasuta*.

lier than those of its competitors. In the cultures of *D. malerkotliana* and *D. n. nasuta*, the former species demonstrates a significantly faster speed of development than the latter. The findings on egg-to-adult viability are recorded in the table 2. (The tables and figures presented herein provides the data for 200/200 egg densities only. Similar observations were made for 100/100 egg densities). So the present data on the egg-to-adult rate of development and viability reveals the superiority of *D. rajasekari* over *D. malerkotliana* and *D. n. nasuta*.

The field data on the distribution of the 3 species under study suggests that they are sympatric[1,2]. We are of the opinion that the concept of sympatry is a dynamic one and within this apparent sympatric coassociation in natural habitats the exact eco-biological status and relationships are not known. The present experimental results have demonstrated one possible outcome of interspecies interactions under controlled laboratory conditions. This alternation in the peaks of adult emergence can be viewed as an ecological homeostatic set-up of species systems to manifest different speeds of development in mixed cultures.

1 Thanks are due to Dr S.R. Ramesh and Iris Sedlak for their assistance in the preparation of the line drawings.
2 To whom reprint requests should be addressed.
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## Heterogeneous ferritin in the blood of two species of Tyrrhenian limpets, *Patella coerulea* L. and *Patella lusitanica* G.

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*Summary.* The hemolymph of *Patella* is yellow and contains 30-300 µg/ml of iron. Ferritin was found to be uniquely abundant in the hemolymph, and was identified by electron microscopy and electrophoresis. Electrophoretically it appears to be heterogeneous, with an individually variable number of components with very similar mobilities. Ferritin in the blood of limpets might relate to the turnover of radular denticles.

Among those molluscs, that have an intense iron metabolism, limpets of the genus *Patella* (Archeogasteropoda) deserve further investigation. The capping material of their radular denticles, which are close to 5 in Moh's hardness scale, contains goethite ($Fe_2O_3$)[1] and their radular muscles contain myoglobin[2]. These features of the buccal apparatus of docoglossan limpets seem to be related to their feeding habits: they are in fact grazers of calcareous algae of the rocky bottoms of the intertidal zone or shallow waters[3,4].

*Materials and methods. Patella coerulea* L. and *Patella lusitanica* G. collected in the gulf of Naples were fixed whole in Bouin's liquid. Their body was separated from the shell and embedded in paraffin wax. Sections were stained in H and E or by Pearls' reaction for iron. Tissue samples from the mantle edge were fixed in $OsO_4$ 1% or in glutaraldehyde 3% in sea water, dehydrated, sometimes stained in toto by uranyl acetate, and embedded in Epon. Sections were observed with a Philips EM200 electron microscope without further electroncontrast.

Blood was collected from the great pallial vein[5]. The iron content of the hemolymph was determined by the method of Lorber[6], and by atomic absorption spectrophotometry (Densatomic, Optica, Milano, Italy). Electrophoretic analysis of filtered and dialyzed hemolymph was performed in Tris-glycine buffer, pH 8.8 at 300 V on Cellogel strips, using horse-spleen ferritin (Pentex Inc.) as a standard. Strips were stained by amidoblack for proteins and by Pearls' reaction for iron. Diluted and undiluted samples of filtered ferritin were layered on formwar-carbon coated grids and observed with the electron microscope.

*Results and discussion.* Pearls' reaction revealed ferric iron in some cells of the hepatopancreas, in the odonthogenic epithelium of the radula and in the radular denticles. The intestinal lumen contained loose fragments of worn denticles still intensely reactive for iron.

The amorphous content of all vascular cavities especially the small lacunar spaces of the pallial tentacles, where blood remained entrapped at the time of fixation, stained