Bull. Sugadaira Montane Res. Cen. No. 11, 121-124 pp. (1990)
(Sugadaira Montane Research Center, University of Tsukuba)

Analysis of evolution in the lower Lepidoptea*

Akira MUTUURA

Biosystematics Research Centre, Central Experimental Farm, Agriculture Canada, Ottawa, Canada

The evolutionary mechanism in Lepidoptera is discussed. As a result of the comparison of evolution between the Microptergidae and the typical Lepidoptera, two different kinds of evolution are recognized. One is more affected by evolution within the species, this is represented by the Micropterygidae; the other is affected by both evolution within the species and evolution by adaptation or co-evolution with the environment, this is represented by trpical Lepidoptera. The former is less related to branching as it shows gradual evolution; in the latter the evolution by adaptation or co-evolution with the enviroment is related to branching, and the repetitive branching shows a rapid evolution.

In distinguishing the two kinds of lepidopterous evolution, the organization is analyzed by discussing the rate of evolution, the adaptive stimulus change for each branching, the importance of considering the character association, evolution of character association, the occurrence of parallelism and the peculiarity of genitalia evolution.

The chances of branching are very low, but if branching occurs, there should be a different adaptive stimulus present, one that does not exist in the mother branch. The adaptive stimulus may be represented by the different environment, different host plant group or species, different insect activity, or different parasite species.

The branching may occur by adult or larval behavioural changes. The branching is induced by adaptive stimulus. The different adaptive stimuli may indicate a change in larval or adult feeding habits, a changing environment, or adaptation to a new living condition for both the adult and the larva.

In evolutionary calculations, one usually considers the degree of evolution by the comparison of each character. However, each character is sometimes developed (and sometimes reduced) by the functional replacement or occurrence of a new function. The development or reduction of each character may not indicate the evolutionary degree, because characters are developed or reduced as a correlation of each character in the character association. Therefore, one should calculate the evolutionary degree by the character correlation in the character association.

* Contribution to the First International Workshop on Lower Lepidoptera: Sugadaira Montane Research Center, University of Tsukuba, Nagano, Japan, July 29-Aug. 1, 1989.

In the lepidopterous evolution, many cases of parallelism are found on the wing marking, wing colour, genitalia, and larval characters. The occurrence of parallelism may be divided into two types. One is a parallelism on the ancestral character or character association which is found on segmental parts or on genitalia. The other is a parallelism on advanced characters which have occurred by the evolution due to living in closely related enviromental conditions. This may be referred to as convergence. The mechanism of the occurrence of parallelism is illustrated in Fig. 1.

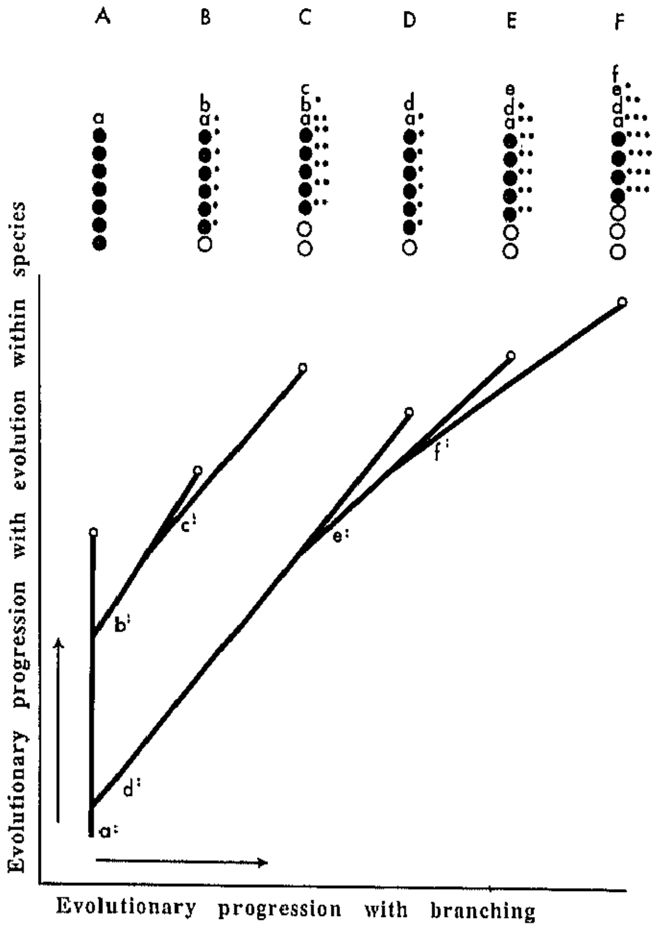

Fig. 1. A simplified illustration of the course of occurrence of parallelism on character or character association, showing a strong possibility that a closely related species or category on B and D, C and E can be mistaken as the resemblance of character presence resulting from parallel development or reduction. A-F, species or category; a-f, acquired character or character association; a: -f: , adaptive stimulus; Large black circle, character or character association; Large white circle, lost character or character association; Small black dot, evolution after branching.

The evolution of the male genitalia is clearly shown by the functional change or functional replacement caused by the loss of the ancestral segment character. This evolution is represented by the loss of the 11th segment, the loss of the 10th sternite, the combination of the 10th tergite and the 9th segment, the outward shift of the paramere developing into the transtilla, juxta, harpe or clasper into the valva, the dvelopment of the gnathos-like process from transtilla, the reduction of the 10th tergite, and the development of the unus-like or valva-like characters from the 8th segment.

The female genitalia may evolve in many ways, e. g., three different egg-laying forms, the development of the telescope terminalia, the development of two genital openings and the advancement of the position of the genital opening. Male genitalia have two different functions. One is the insertion of the aedoeagus, the other is to grasp the female terminalia. The female genitalia have three separate functions. The first is reception for insertion of the aedoeagus, the second is to assist the male in grasping, and the third is egg laying.

The genitalia have co-evolved through the correlation of five different functions. This correlation is quite different from that of the other character associations, bacause each of the other character associations usually evolves with only one or two functions. Also, the development or reduction by this complex correlation is suited for the investigation of an individual phylogenetic course. Moreover, the genitalia have evolved by evolution within the species and basically as a co-evolution between the male and female. Therefore, genitalia evolution is not directly influenced by branching. Hence the genitalia evolution exhibits the phylogenetic relationship.

From these studies' views: different combination of the 8th sternite and genitalia segments between Zeuloptera and other panorpid complex including Lepidoptera, differences of larval host in primitive groups, reduction or lost mandible as the parallelism, development or reduction of thoracic legs or prolegs of larvae, and different evolutionary courses of male and female genitalia; the transition of ancestral species to flowering plants may have occurred several times causing different evolutionary courses and host relationships. A hypotheses of the food transition to flowering plants is illustrated in Fig. 2.

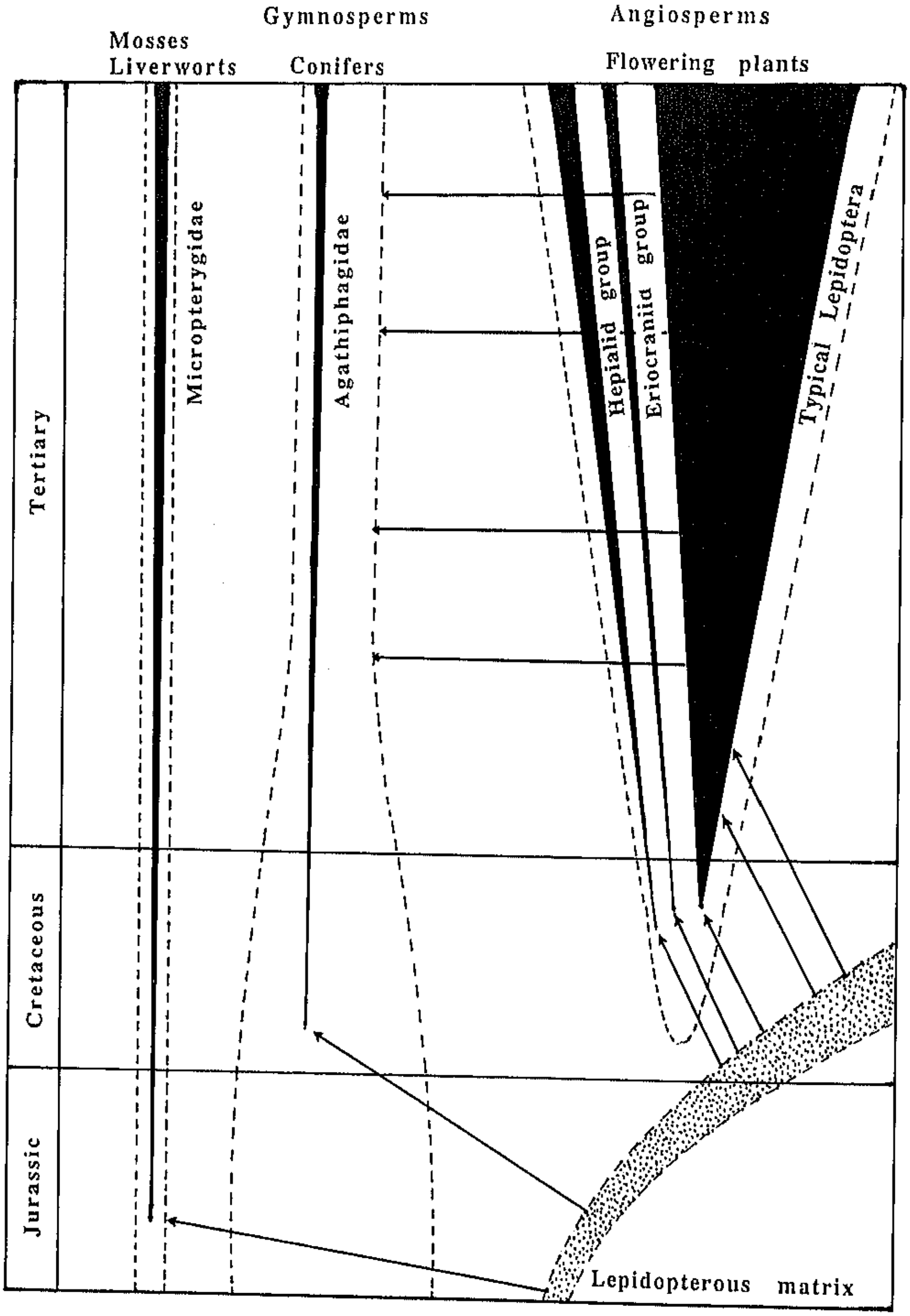

Fig. 2. A hypothesis of the food transition to flowering plant showing several different transitions of larval food from dead plant tissue or fungi to living tissue of flowering plants.