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NEW DEVELOPMENTS IN THE BIOLOGY OF CHRYSOMELIDAE

By P. Jolivet, J.A. Santiago-Blay and M. Schmitt (Editors)

S.P.B. Academic Publishing bv, The Hague, The Netherlands. 2004. Pp. xix+840+ some pages on an enclosed CD-Rom (hard cover). Marketed by: BRILL, P.O. Box 9000, 2300PA, Leiden, The Netherlands.

This book, published in 2004, is yet another effort to present in a concentrated form the current trends in the study of the very large family of phytophagous beetles, the Family Chrysomelidae. Before this publication Prof. P. Jolivet of Paris, along with some leading chrysomelidologists, edited a series of collective books on Chrysomelidae, with very useful papers and reviews, which proved a great help to researchers on chrysomelid beetles. The earlier publications include: *Biology of Chrysomelidae* (1988) (Editors P. Jolivet, E. Petitpierre, & T.H. Hsiao), *Novel Aspects of the Biology of Chrysomelidae* (Editors P. Jolivet, M.L. Cox & E. Petitpierre), and *Chrysomelidae Biology* in three volumes (1996) (Editors P. Jolivet & M. L. Cox). The volume, under review, is a welcome addition to this series.

The chapters or papers in this edited book have been arranged under ten sections.

Section 1 is on "Phylogeny, Molecular Biology". This section is a unique feature of this book, as none of the earlier publications in the series covered molecular biology. In this section Gomez-Zurita, Kopliku *et al*. have introduced molecular systematics in a clear lucid way, and have described the methods, used in this new branch of Systematics in details with helpful figures.

Duckett, Gillespie *et al.* in the Section 1, in their contribution, have worked out relationships among chrysomelid subfamilies, particularly between Galerucinae and Alticinae, using ribosomal DNA analysis and morphological features. Their study brings out phyletic closeness between Galerucinae and alticinae. It also shows phyletic distance between *Syneta* and Eumolpinae, and phyletic closeness between *Syneta* and Galerucinae + Alticinae (their Fig. 1). It is of interest that this phyletic position of *Syneta* has been inferred from morphological features by Verma and Jolivet (2000) earlier.

Section 2 is on "Statistics", and this again is a novel feature in this series of volumes, appearing on chrysomelid biology in the recent past. This section includes only one paper, "Some considerations for the use of statistical methods in Chrysomelidae" by Hayek. In this chapter usefulness of inclusion of statistical treatment in chrysomelid studies has been brought out. Results from studies on niche separation between related species, estimation of densities of two species in the same locality, ecological studies and a morphometric approach may all adopt statistical methods to make their inferences well defined and acceptable. It has been suggested by the author that to pose a definite question and to keep in mind a hypothetical answer to it before performing an experiment or planning a survey or exploration would lead to such data sets as may be suitable for a statistical treatment. It has been pointed out that collections in museum drawers and field collections, made without any bias, may be taken as random collections. It has been clarified that the probability worked out through a statistical procedure is not for the natural population, studied, but for the correctness of inferences drawn. This principle is specially relevant when dealing with biological populations in view of their immense variability.

The Section 3, "Morphology and Anatomy" includes eight papers/ chapters. M. Schmitt, in his contribution has described and discussed the jumping mechanism and performance in flea beetles (Alticinae), an area in which David Furth authored a number of papers during 1980s and 1990s. Through his critical studies Schmitt has inferred that in most Alticinae, studied by him, there is a linear relationship between the maximum jump length and the hind femur volume, which reflects the muscle volume in this part of the leg.

Verma and Kalaichelvan, in their chapter "Polymorphism and microtaxonomy in Chrysomelidae" have surveyed several cases of polymorphism among the leaf beetles, and have noted that these cases agree with the view that polymorphism results from different segments of a population getting adapted to different subareas or niches of a large geographical area, followed by secondary migrations and consequent gene flow among these population segments. Such factors as continued gene flow, mutation-selection balance, heterosis, frequency dependent selection etc. provide stability to polymorphism, and prevent its erosion from further selection. The authors have enlisted a number of ways or steps to avoid taking morphs or phena of a polymorphic species as separate species, and thus to reduce the need and burden of subsequent synonymisation.

Grenha, Margarete et al., in their paper in the Section 3, have recorded geographical variation in the hispine beetle *Mecistomela marginata*. They find that yellow, red and orange body colour morphs of this beetle occur in different parts of Rio de Janaeiro State, and they have noted that there are no mechanical and behavioural barriers to prevent cross mating between the red and the yellow morphs. The authors plan further experiments and study of this polymorphic species. Their observations so far have agreed well with what has been inferred about origin of polymorphism by Verma and Kalaichelvan in their paper (vide supra).

Ghate, Swietojanska et al. have authored an excellent paper, "Immature stages and bionomy of some Indian species of *Chiridopsis* Spaeth (Col., Chrysomelidae, Cassidinae)". They have figured and described in detail the first and last larval instars, pupae of four species of *Chiridopsis*, and have also noted their biology. Chaboo and Nguyen, in their paper in the Section 3, have given an account of immature stages of the cassidine *Hemisphaerota palmarum*, specially of the larval caudal processes and the shield architecture, comparing these features with those in two other species of *Hemisphaerota* and three species of *Spaethiella*. If taxonomists, working on leaf beetles, emulate the approach of these authors, it will become feasible to identify species through examination of immature stages.

Jolivet has chosen for his contribution to the Section 3 an unusual topic, "Adaptations of Chrysomelidae (Col.) from xeric regions". Chrysomelidae, being phytophagous, almost all cannot do without rich vegetation. But a small number of them (less than 2%) do occur in desert regions. Larvae of Clytrinae feed on detritus, excreta, and cadavers of other insects, and their adults are polyphagous; hence they are dominant among desert chrysomelids. In addition Chrysomelinae, Galerucinae, Alticinae and some other subfamilies are represented in deserts by a small number of species. In areas of recent desertification, e.g. the Sahara, leaf beetles have survived on mountains, plateaus and oases. They also occur in fringes of desert

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areas. Xeric chrysomelids show a number of structural modifications. Commonly they show apterism, fusion of elytra, and presence of a subelytral cavity due to absence of wings. Spiracles, located in the subelytral cavity, are able to respire in a more humid situation; thus conservation of body water is achieved. Apterism and loss of wing muscles allow enlargement of abdomen, helping in attaining a larger storage of water and food in the body. Desert leaf beetles may also show reduction of tarsal pubescence, making the tarsi better adapted to digging in sand. This paper covers the arctic deserts and steppes, in addition to typical sandy deserts.

The "Palaeontology" section (Section 4) comprises of three papers. The paper by Anderson, Craig *et al*. points out that a number of web sites mention fossil chrysomelids. These fossils have been found mostly in amber, and are in possession of private collectors. Hence they are not available to taxonomists and experts for adequate description and bringing them to scientific record. In this situation the fossil record of beetles is suffering from stunted growth. Besides there are some fake descriptions of chrysomelid fossils.

Hayashi has contributed a paper on a detailed study of donaciin fossils of the quaternary period from central Japan, and has made out changes in this aquatic beetle faun during that period.

Santiago-Blay, Savini *et al.* have given an account of a new fossil species of Alticinae, *Wanderbittiana wawasita* from Dominican amber.

Section 5, "Relation to Plants" includes six papers. Poinar and Jolivet, in their contribution under this section, have attempted to work out the dispersion history of the archaic and interesting chrysomelid, *Timarcha*, on basis of fossil record and present distribution of its host plants. They have inferred that the origin of *Timarcha* was in Jurassic, in an eastern part of Siberia, and that from here it migrated westward to Europe and eastward to North America, when the Sea Tethys was still continuous across the globe.

In this section Santiago-Blay has contributed an extensive and valuable review on leaf mining larvae among Chrysomelidae. In the book only "Abstract" of the paper is in print, while the body of the paper is on a CD-ROM, enclosed with the book. Leaf mining larvae are prolonged feeders of leaf tissue, feeding between the two epidermal layers of a leaf, and eliciting a histological response from the plant. Of the total number of described chrysomelid species only 1 to 2% have leaf mining larvae. Such larvae are known from the subfamilies Zeugophorinae, Criocerinae, Galerucinae, Alticinae, Hispinae and Cassidinae. The largest number of leaf miners are in Hispinae, about 40% of the total number of hispine genera. Chysomelids with leaf mining larvae are generally polyphagous.

Staines has reviewed literature on association of cassidines (Cassidinae + Hispinae) with the plants of Zingiberales. Medeiros, Boligon *et al.* have discussed morphological and behavioural adaptations for movements of cassidine larvae on leaf surfaces with different textures. Fornasari has recorded ecology of some Alticinae on *Euphorbia* plants in Eurasia, specially in *Aphthona*, some exotic species of which have been used in North America for biocontrol of invasive species of *Euphorbia* with beneficial effects. Walsh and Cabrera have, in their paper, given an account of distribution and systematics of Diabroticina (Galerucinae, Luperini) in Argentina and southern South America.

There is a large section (Section 6) on "Biological and Ecological Studies". Under this section Cox has provided a useful review on flight behaviour of Bruchidae and Chrysomelidae, based on an extensive bibliography. Of special interest is the portion on "Hormonal control of flight". In this part the author points to an "inverse relationship between flight and reproduction", a notion which is well supported by references.

Verma and Jolivet, in their contribution in this section, "Primitive Eumolpinae and the Gondwana Hypothesis" have compared morphological features and developmental stages of the members of the primitive eumolpine tribe Spilopyrini, and have inferred a monophyletic origin of the group. Members of this tribe, occurring in S. America, Australia, New Guinea and New Caledonia, provide another support for the Gondwana Hypothesis, which of late has been gaining strength through a number of biogeographical evidences coming to light.

Santiago-Blay's long paper on Aulacoscelinae not only includes a review summary of all that has been published on biology of these leaf beetles but also their close-up photographs to help identification, and description of three new species of *Janbechynea*. The body of this long paper too is on a CD-Rom, enclosed with the book, like his another contribution, the one on leaf mining chrysomelids.

In addition there are contributions in this section on biology and ecology of a number of different chrysomelids.

Under Section 7, "Population Biology" are included 8 papers. In this section Staines, in his contribution, has compared the chrysomelid fauna of the Maryland River Island (USA) as recorded in 1902-1903 and as found in 1997-1998. It has been noted that in the intervening period of about 95 years species richness has declined by only 2.1%. Another change noted: a slight increase in the number of monophagous and narrowly oligophagous species and corresponding decrease in the number of polyphagous and broadly oligophagous forms. The author believes that this latter change has been due to "a faunal response to plant community succession".

In Section 7 is an interesting paper on population dynamics of a chrysomelid, *Zygogramma suturalis* by Kovalev. This chrysomeline leaf beetle has been introduced in northern Caucasus from North America for biocontrol of the ragweed (*Ambrosia artemisiifolia*). The introduced beetle forms a "solitary population wave" (SPW) moving ahead, effectively destroying the weed. As the SPW advances, two remarkable changes take place in the insect, namely increasing melanisation and appearance of flight capacity, though in the home country the beetle is a nonflying species. About the development of flying the author says, "The formation of 'flyers' had only taken place under high population density stress within the SPW ….". There is a notable parallel between this case and what has been recorded in bruchid populations by George and Verma (1994) and in locust population dynamics by Staal (1961).

Another paper in Section 7, which has drawn my attention, is by Kippenberg, "Diversity of aedeagus shape in Slovenian population of *Chrysolina purpurascens* (Germar)". This paper describes sympatric coexistence of different aedeagus forms in the chrysomelid in western Slovenia. This variability in the aedeagal structure is in contradiction of the notion, generally accepted by insect taxonomists, that genital features are stable within a species. To explain the origin of this unusual aedeagal polymorphism Kippenberg has offered a convincing hypothesis. He points out that in the hilly western Slovenia there are numerous limestone caves, many of which have their roof partly collapsed, so that they take the form of a "sink", that is a funnel-like gap with a narrow opening. The sinks present an inversion of temperature; i.e. the temperature is considerably lower than what it is outside. In Pleistocene Slovenia was often much warmer than what it is today. Hence the beetle *C. purpurascens*, adapted to live in more temperate climate, retreated into the sinks. Thus the western Slovenian population of the beetle got divided into a number of minipopulations, in which, due to genetic drift, the aedeagal form became somewhat different. More recently the population segments emerged from the sinks, and became truly sympatric with the aedeagal polymorphism. This hypothesis is in good agreement with the explanation of origin of polymorphism in the chapter "Ploymorphism and microtaxonomy in Chrysomelidae" by Verma and Kalaichelvan in the Section 3 of this book.

Section 8, "Defenses" is a collection of three papers. The paper by Pasteels, Daloze *et al.* is on defence through toxins present in secretions of exocrine glands of some neotropical leaf beetles, belonging to 11 genera and 30 species. They find that the chemical nature of the toxins support the previous classification of these genera in three subgeneric groupings, made by the Pasteels' school. But "Host plant association was found to be far less conserved during evolution".

In another paper Pasteels and Hartmann have described different sequestration pathways for production of pyrolizidine alkaloids (PAs) from plant acquired PAs in *Oreina* and *Platyphora*, though the end product is the same in the two genera.

In their paper Muller and Hilker have discussed ecological relevance of fecal matter in Chrysomelidae. While in general the fecal discharges of leaf beetles have a role in recycling of organic matter in the ecosystem, in many leaf beetles the fecal cover on eggs and later developmental stages have a defensive value. Besides the feces may include pheromones for intraspecific communication, and may also act as kairomones, which help predators and parasitoids in locating their prey.

Section 9 is on "Sexuality and Reproduction". Four papers have been kept in this section. An interesting paper is by Tallamy on male choice by female after intromission in *Diabrotica undecimpunctata*. The male in copula, after achieving vaginal penetration, strokes the female with its antennae. After sometime the stroking stops. By dissecting flash frozen copulating pairs during and after the stroking phase it has been noted that during the stroking phase the musculature around the vaginal duct, leading into the bursa, is kept contracted, so that the bursa cannot be penetrated. It is in the post-stroking phase that the musculature may be relaxed allowing penetration of the bursa too and deposition of the spermatophore in it. In this respect only some copulations are successful. The successful and failing males have been carefully compared with respect to body size and weight, aedeagal length, presence and amount of cucubitacins in the spermatophore etc. (In this species only males visit plants with cucurbitacins and get these defensive toxins from them. Females obtain cucurbitacins from the spermatophore, placed by the male in their vaginal passage.) But only one differnce could be noted; the successful males did antennal stroking with greater frequency. The basis of this male behaviour, evoking favourable response from female, seems to be in some way genetic, as the male offspring of successful males are also fast strokers and successful in mating.

Rodriguez, Windsor *et al.*, in their paper "Tortoise beetle genitalia and demonstration of a sexually selected advantage for flagellum length in *Chelymorpha alternans*…" have given results of their study of genitalia in 59 neotropical cassidine species, and certain mating experiments in *Chelymorpha alternans*. They have found: (1) A strong correlation between the length of the spermathecal duct and that of the flagellum in the male aedeagal apparatus. (2) That in *C. alternans* the flagellum length gives a definite reproductive advantage to the male, as males with longer flagellum father more offspring in multiple matings, and a virgin female, mating with a male with longer flagellum, less often discharges sperm droplets during mating. (3) That greater the quantity of sperms emitted during mating by the female the smaller the number of sperms in her spermatheca.

In Section 10 "Biological control" there are two papers. In their paper Bourgeois, Goillot *et al.* have provided new data on biology and ecology of *Phaedon fulvescence,* which has been introduced in the island Reunion from S. E. Asia for control of the invasive plant *Rubus alceifolius*, and is a potential biocontrol agent for this noxious weed.

In the other paper under Section 10 Viraktamath, Basavaraj *et al*. have described biology and ecology of *Zygogramma bicolorata*, which has been brought into India from Mexico for control of the invasive carrot weed, *Parthenium hysterophorus*, and have discussed factors for success in achieving the control in some parts of India and the factors leading to failure of this biocontrol agent in suppressing the weed in some other parts.

As has been said by the editors in the Epilogue, "Numerous interesting features of the Chrysomelidae have been brought under the spotlight in the current volume". All papers in this big volume are valuable contributions, but reference to and comments on some chapters have not been given in this review due to constraint of review length. It is hoped that availability of this book in universities and research institutes and to research workers will give impetus to researches on Chrysomelidae and will suggest fresh directions of enquiry and investigations.

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