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A Butterfly-Moth (Lepidoptera Castniidae) from the Oligocene Shales of Florissant, Colorado

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Abstract. An Oligocene fossil from Florissant, of the moth family Castniidae is named as *Dominickus castnioides*. The find may be of particular interest because indications are that the Castniidae seem to represent an early branch from the same stem which led to the present day Rhopalocera or butterflies.

Introduction

The Florissant Lake Bed Shales outcrop around the hamlet of Florissant in Teller County, Colorado (105° 19′ W. Long. x 38° 56′ N. Lat.). They have attracted attention from several generations of entomologists since their discovery as insect-bearing beds in the 1870's, by A. C. Peale M.D., a geologist on the Hayden Survey of the Territories.

The shales are composed of fine to coarse pyroclastic particles from Oligocene volcanics present near Guffey, some ten miles (16 km) to the southwest. Thousands of insect fossils have been recovered from these shales, and in the course of time more than one discovery has been made of the wing impressions of Lepidoptera, but these have been rare as compared with indications of the remains of other fossil insects.

While a member of the staff of the University of Colorado in Boulder, some years ago, I made several visits to Florissant but, despite some twenty hours spent in splitting these shales at a favorable locality, failed to find any trace of a lepidopteran fossil, although remains of other insect orders were obtained for the University collection.

F. Martin Brown recently sent me a lepidopteran wing specimen from these shales, for study. It was from a small collection of the fossils preserved in the Field Museum of Natural History in Chicago, where it is registered as their no. P.22949.

At first sight the wing impression appeared very confusing, but after detailed examination, making independent drawings at intervals of time and using different lightings, it became evident, as had been detected earlier by Brown, that the insect had died with its wings folded down over its body in such a fashion that the apices of the two forewings had chanced to be so exactly superimposed that the venation of one forewing was imprinted on the other with no more than a fractional lack of register. Thus there was formed a 'ghostly' repeat of the vein pattern of the right forewing below, on the left one, exposed above. No trace of the body sur-

vived and the hindwings were gone, save for a faint probable impression of a frenulum, as will be mentioned in a later paragraph of this paper.

Two photographs of the Oligocene fossil are shown, the best of more than a dozen taken using different artificial lightings, on ektachrome film. Figure 1 was taken at natural size and is now enlarged. White light was directed, at close to 45° angle, using also general illumination from a fluorescent tube light with added black light. This chanced to reveal a rather clear indication of the main lines of the venation and, so far as preserved, an indication of the outline of the wing itself; the impressions interpreted as those of the underlying right wing venation are sufficiently differentiated as to give some confidence that they may be distinguished from the veins of the overlying and more useful left wing.

Figure 2 was taken at twice natural size using only white light, the lamp source being set at about 30°, again from the upper right. This photograph does not emphasize so clearly the full outline of the wing, but it has given excellent indication of the veins of the left wing with relatively little interference from the underlying veins of the right wing.

In both of the above described photographs there is a suggestion of a differentiated or darkened apical area of the wing. It is not clear to me whether the difference registers an indication of a former wing color pattern or whether it is an artifact of chance.

Figure 3 is a drawing showing a deciphering of as much of the venation as preserved on the upper side of the left forewing. It has been mirror-imaged to conform to a convention of depicting the right wing when making comparisons with other species. The veins are labelled according to the system used by me in my earlier work, based on the notations of R. J. Tillyard, save that the postcubital vein is indicated as Pcu and the following, anally situated veins are indicated as vannal veins, 1V and 2V, following the lead of Snodgrass (1935), and supported by Ehrlich (1958).

Family Position of the Oligocene Wing

An early conclusion was reached that there was no good evidence linking the fossil with any member of the homoneurous Lepidoptera. Factors considered included the wide wing and the rather midwing position of the fork of Cu_{1a} and Cu_{1b}. This led indirectly to a consideration whether it could be linked with a hypothetical ancestor of the Hesperioidea and the Papilionoidea. It then became evident that there was a distinct indication of a possible relationship with the still living and curious day-flying moths of the family Castniidae, often known as Butterfly-moths.

In the superfamily Castnioidea there are known to be more than two hundred living species, usually recognized as divided among three families, of which the Castniidae occur chiefly in Australia, and South and Central America. Members of the other two families live in South East Asia, Madagascar and continental Africa.

Fig. 1. *Dominickus castnioides*. Florissant, Oligocene. Forewing showing wing outline and faint impressions of a possible wing pattern.

Fig. 2. *Dominickus castnioides*. Florissant, Oligocene. Forewing with low lighting to show principally the veins of the left wing.

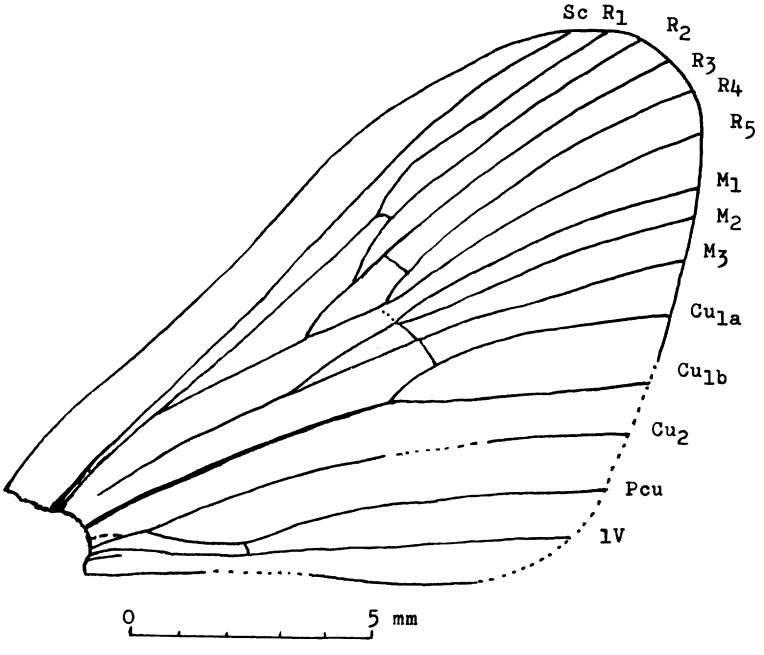

Fig. 3. Venation of forewing of *Dominickus castnioides*, Florissant, Oligocene; presumed to be of a male.

The genus *Synemon sensu latu*, with perhaps fifty species occurs in Australia. They live chiefly in the more temperate and sometimes semi-arid parts of the continent. Some of them are of the size of the Oligocene fossil under consideration. American species of the Castniidae are, or should be, placed in several genera but there is still much uncertainty as to generic terminologies and many authors still retain them all under the one generic designation *Castnia*.

Unlike the generality of moth species the castniids possess clubbed antennae like the butterflies and are thought generally to be day-flying. They are noted for displaying bright and conspicuous color patterns on the undersides of their wings as well as on the upper surfaces. In this regard they resemble the butterflies and especially in tropical America, flying in bright sunshine, some of them take part in the Mullerian mimicry complexes which are a feature of some butterfly species. In recent papers (Tindale,1980, 1981) I advanced a belief that members of the family Castniidae may have preserved venational similarities common to a joint ancestor with the butterfly stem, perhaps in the Mesozoic. For this and other reasons the Florissant fossil may be of particular interest and may be described in the following terms:

Family CASTNIIDAE

Dominickus Tindale, **new genus**

Description. Forewing broadly triangular, with rounded apex, and with rather straight termen, and almost straight hind margin. Venational pattern substantially of castniid type with R veins supporting the costal third of the wing. Sc vein is simple, R_1 from R_s at one-fifth, an ir crossvein linking R_1 with R_2 at three-fifths; R_3 and R_4 also joined by an ir vein after branching of R_4 and R_5, thus forming a cell. R and M_1 were almost certainly joined by a crossvein, rm, in the middle of the wing, but the presence of a coarser than usual particle has created a defect; in the drawing of the venation its likely position has been indicated by several dots. Cu_1 is a particularly strong vein in its basal half, branching to Cu_{1a} and Cu_{1b} close to the central point of the wing. Cu_2 and Pcu are joined near the base of the wing and Pcu is linked with 1V by a crossvein. There is a short indication of a possible 2V near the base of the wing.

Type. *Dominickus castnioides*. From the Oligocene Lake Bed Shales of Florissant in Teller County, Colorado.

The single species so far recognized in this genus appears to be a member of the superfamily Castnioidea and has been placed, on preliminary assessment of data, as belonging within the family Castniidae for reasons given in the general discussion which follows. The generic name is proposed in memory of Dr. Richard Dominick who did so much for the study of the moths of North America during his all too short life.

Dominickus castnioides Tindale, **new species**

Description. Its characteristics are as set out in the above generic description and shown in the accompanying drawing of the venation and the photographs. The state of preservation does not indicate the wing scales but the softened outline of the preserved part of the termen suggests a fringe similar to that present in other Castniid moths. Photographs seem to suggest the survival of indications of a color pattern in which the costal area narrowly from near the base and more widely from midwing was dark-colored as also the termen to the hind angle, with a broad band of some possibly lighter color extending from the costa at two-thirds toward the hind margin as far as M_3 where it terminated. The basal part of the wing appears to have been light-colored, with the hue extending to the hind margin. The veins in the light-colored areas perhaps were marked by darker scales than the rest of the wing.

The length of the preserved part of the wing, virtually its whole, is 16.4 mm and its width, measured from midcosta to the hind angle, is 9.4 mm.

Type. A forewing, no. P.22949 in the Field Museum, Chicago, Illinois. It was taken from the Florissant Lake Bed Shales, of Oligocene Age, in Florissant, Teller County, Colorado (105° 19′ West Long. x 38° 56′ North Lat.).

Relationship of *Dominickus castnioides*

Resemblances between this species and other members of the family Castniidae were noted first during a comparison with the venation of a Western Australian species of the genus *Synemon* identified as *S. leucospila* Meyrick 1891 and figured herein (Fig. 4). The drawing shows a ventral view of the forewing of a male. Its length, 16 mm, is close to that of the

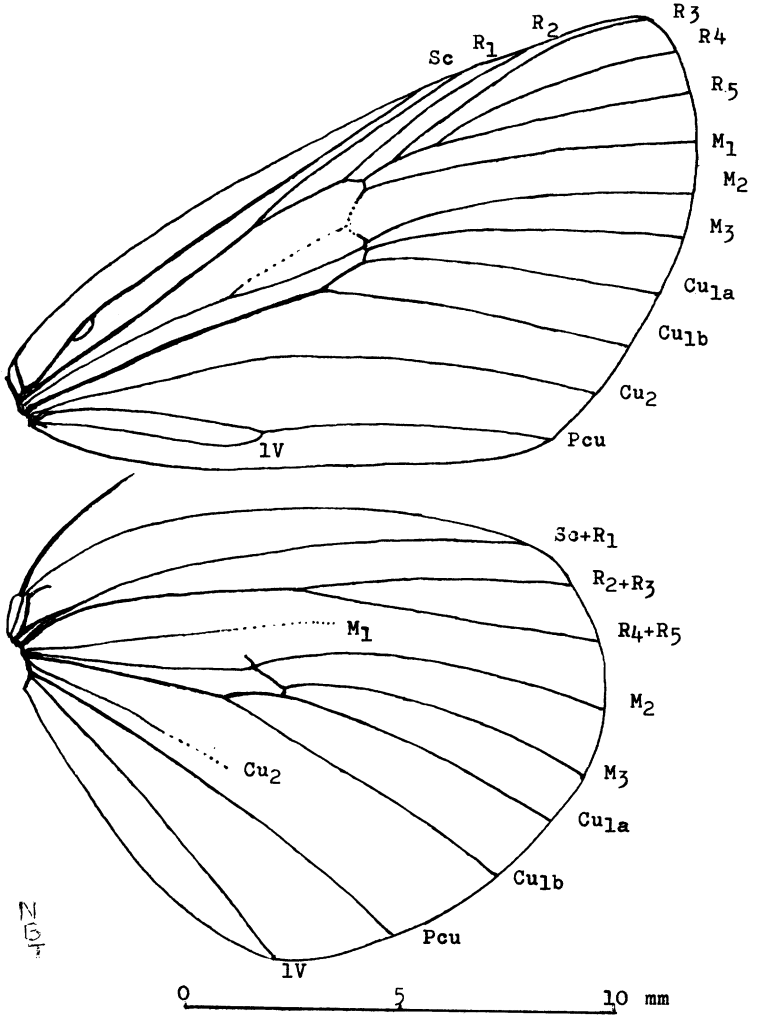

Fig. 4. Venation of wings of a male of *Synemon leucospila* from Hawks Head Lookout, Murchison River, Western Australia.

Oligocene fossil under consideration. The hindwing also is shown to indicate the length and general position of the frenulum. The depicted specimen was one of a series taken flying in mid-afternoon at Hawks Head Lookout, two miles (3.2 km) south of the mouth of the Murchison River on 6 November 1968. There are distinct resemblances between *S. leucospila* and the fossil, but the M_1 vein was less well developed, and 1V did not extend to the margin in the living species. Through the kindness

of L. E. Pena G. of Santiago I was able to make comparison also with examples of a Chilean species identified as *Castnia psittacus* (Molina, 1781) by Ureta (1955) which, although larger in size showed an even closer resemblance to *Dominickus*, with close similarities in the M_1 region of the wing and both Pcu and 1V vein extending to the anal angle, with a well-developed 2V vein in the place of the remnant only visible in *S. leucospila*. The ventral view of the forewing venation of a male of this South American species is shown as Figure 5. Its length is 22 mm and it was taken at Divisidero, Ovalle, Chile, 15/17 December 1977 by L. E. Pena G.

Links between the Chilean species and the fossil from Florissant seem greater than with *Synemon*. Both M and Pcu areas are similar and the R veins, in the center of the wing show considerable resemblances and comparable complexities of linkage; the principal difference appearing to be the lack of an ir crossvein between R_1 and R_2 in *C. psittacus*, as also in other Castniids examined. This difference could encourage a view that *Dominickus* should be set in a family of its own but within the Castnioidea.

Near the base of the wing of the fossil there is a faintly appearing oblique mark which I had not noticed when first making observations. However F. Martin Brown, upon learning of my tentative identification linking the

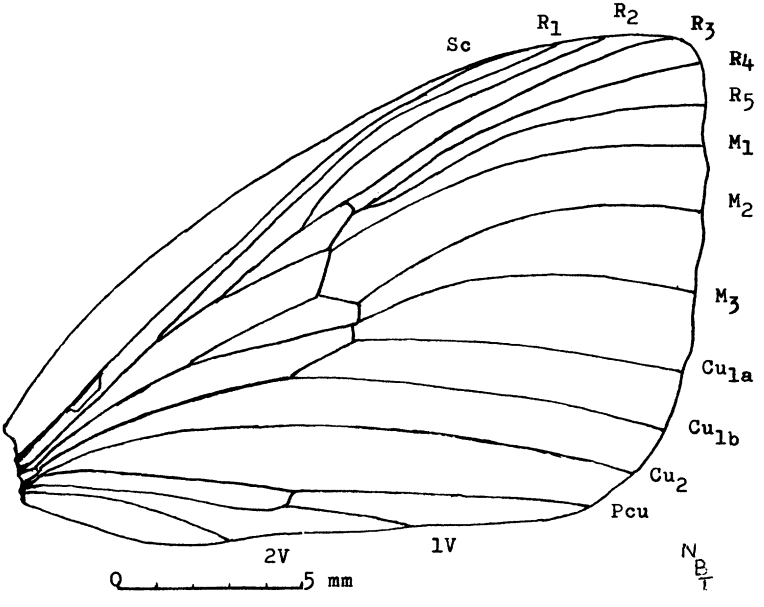

Fig. 5. Venation of forewing of a male of *Castnia psittacus* from Divisidero, Ovalle, Chile.

fossil with the Castniidae, wrote 'I thought I saw a trace of frenulum near the base of one of the overlapping wings when I studied the fossil, but was not at all sure.' Such an obliquely set raised indication of pressure from beneath does appear at an appropriate place and also seems to have left traces where a frenulum-like spine passed under the M and Cu veins. if the interpretation is valid we may assume that the type specimen of *D. castnioides* could have been that of a male.

Superimpositions of drawings of the three venations mentioned above were studied. Using Cu_1 as a baseline and the point of parting of Cu_{1a} and Cu_{1b} as an arbitrary central point in the wings it appeared that the direction of change with time between *Dominickus* and the living *Synemon* showed a strengthening of the costal area by the contraction and crowding of the R veins. There is also considerable expansion of the terminal area of the wing in *Synemon*. When a similar comparison was made between the Oligocene fossil wing and the *Castnia* one from Chile the contraction and strengthening of the costal area was far less with time although the terminal expansion was similar to that in *Synemon*. From indications such as this we may be correct in assuming that *Castnia* as it occurs in America may be a little closer to *Dominickus* or has changed somewhat less than *Synemon*.

Having established a probability that the Florissant wing was linked with the American section of the family Castniidae a check indicated that while they were very numerous in the American tropics some species had ranges extending into more temperate areas and that no fewer than five species had been recorded from Mexico, two living less than 1250 miles (2000 km) south of Florissant, in Colorado. A short list of reported Mexican species included the following, with a few of their known localities:

Castnia atymnius Dolman	*VERA CRUZ: Cordoba (subspecies futilis* Walker)
Castnia chelone Hopffer	VERA CRUZ: Cordoba, Jalapa and Orizaba
Castnia escalantei Miller	GUERRERO: Acahuitzola
Castnia estherae Miller	MICHOACAN: Purua
Castnia inca Herrich-Schaeffer	TAMAULIPAS: Tampico

Not having immediate access to any of these it was fortunate that Miller (1976) had made drawings of the basal halves of the wing venations of several Mexican species of *Castnia* which seemed to show close resemblances as well as variations of veins which could well link with the corresponding veins in *Dominickus*. Taking the data Miller gives for the species *Castnia escalantei*, which she described as new, it can be seen that there are detailed similarities in the Pcu and 1V veins although there is seemingly a difference in the absence in her drawing of one of the R veins, perhaps a casual difference, for in the species *Castnia estherae* which she also described as new the full complement of veins are present with the

complex arrangement of cells similar to *Dominickus*. The most outstanding difference seems to be the presence in *Dominickus* of what has been mentioned earlier in this paper as an apparent ir vein joining R_1 and R_2. The full significance of this ir vein is yet to be determined.

In other papers, Tindale, 1980, 1981 I have considered the possibility that members of the family Castniidae may supply indications of the ancestral line of the Papilionoidea and the Hesperioidea and therefore, if the evidence afforded by *Dominickus* is valid it can be assumed that the castnioid wing pattern was already well defined by the Oligocene. Further study of the Mexican species will very likely confirm what has been suspected by me for some time that the patterns of Lepidoptera evolution in subtropical North America were very ancient, as has been indicated by the even longer and most striking link evident between the Papilionid fossil *Praepapilio colorado* Durden and Rose 1978, from the Middle Eocene of the Green River Shales in Rio Blanco County, Colorado, and the living Mexican Papilionid *Baronia brevicornis* Salvin 1893.

Acknowledgments. I am indebted to F. Martin Brown for his detailed outline of the Florissant geological situation and for encouragement in the search for the possible family relationship of this fossil moth, also for his notice of the impression of a frenulum and thus for the possibility of determining the sex of the *Dominickus* type specimen as a male.

My correspondent, L. E. Pena G. helped by providing examples of a Chilean *Castnia* for study, and I thank Noel McFarland of Sierra Vista, Arizona, with whom I collected specimens of *Synemon*, in Western Australia, on our joint field trip in 1968.

I acknowledge also the very useful comments on my paper given by Jacqueline Miller. She suggested that the four to seven frenulate hairs present in the females of castniids, which often tend to be well clumped distally are such that the assessment of the type specimen of *Dominickus* as a male may be a little less than certain. The venation of *C. escalantei* was closer to the fossil than indicated since she reported that the R vein missing from her drawing was an error. Miller also has provided a list of five additional species reported from Mexico:

C. (Xanthocastnia) viryi (Boisduval)	OAXACA, CHIAPAS
C. (Cyanostola) diva Butler	VERA CRUZ, CHIAPAS
C. (Orthia) delecta Schaus	VERA CRUZ
C. (Orthia) hectiae Dyar	VERA CRUZ
C. (Orthia) miustagma Dyar	GUERRERO

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