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THE REMARKABLE LIFE-HISTORY OF A NEW FAMILY (*MICROMALTHIDÆ*) OF BEETLES.

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During an attempt, still progressing, to secure by breeding all of the stages in the paedogenetic beetle, *Micromalthus debilis* Lec., certain astonishing facts have become evident which make the life-history of this beetle the most remarkable in the Coleoptera, if not one of the most remarkable in the whole class Insecta. Although still far from complete the publication of the life-history, as now known or foreseen, may cause students investigating other life-histories to look for hitherto unsuspected features in their problems, which if not really looked for, would pass unnoticed.

In a preliminary paper (Proc. Ent. Soc. Wash. 1913, vol. XV, pp. 31–38, plates II and III) the writer has illustrated the paedogenetic mother and young of this beetle, but the subsequent observations show that only a small part of the life-history was known at that time.

Micromalthus presents perhaps the most plastic larval forms yet known, combined with a practically fixed adult form of wide distribution. No close relatives are known, and it seems remarkable that specimens from Michigan, Kentucky and Virginia should exhibit no tendency towards local variation in a species apparently of such feeble powers of migration. It combines in its life cycle—eggs by two methods of reproduction, seven or eight forms of larvae, adults through two distinct lines of larvae, oviparous paedogenesis and viviparous paedogenesis. The species appears to present a beautiful case of sex-determina-

tion and this also seems to be an effective barrier against inbreeding; for males and females of the same brood appear unable to issue simultaneously on account of the interpolated larval stages of the former.

The breeding of the specimens is not difficult, except when too frequently disturbed. The larvae do not appear well able to readjust their surroundings after the gallery is opened, and the adherence of the skin to any smooth surface like glass has prevented their being kept in thin sections between microscope slides. Chips of wood kept in plaster cells have given best results, but the life-history must be pieced together out of disjointed observations and occasional thorough examinations of breeding material of known origin.

Beginning with the young larva born by the paedogenetic mother larva, we have a minute white larva principally conspicuous by its long, slender legs of the carabid type—*i. e.* coxa, trochanter, femur, tibia, *tarsus and two claws*. The remains of the mother are usually consumed by some of her young, after which all crawl away. This stage is to the species a minor migratory form, securing dispersal into new parts of the log in which the colony is living. After crawling out of the mother's cell the young wander for a time, then start burrowing into the wood again, feed a little and after a week or so moult into the second form which is legless and much resembles a Cerambycid larva, but for its odd but inconspicuous anal armature. A second or perhaps a third moult must occur in this form to allow for growth of head. The larva bores through the wood, packing its gallery tightly behind it with dust for some months, the body appearing dark colored from the food in the alimentary tract. During the latter part of this growth the eggs in the ovaries of what will be the paedogenetic form become plainly evident as large obliquely placed, oval, white bodies on each side of the distended and dark colored alimentary tract. When full fed it reverses its position in the gallery, makes a cell and begins to "aestivate." Gradually the body becomes white until no food is left in the alimentary tract. It then either, very rarely, pupates, or usually, moults, diselosing the paedogenetic form. After a period of about two weeks the young numbering from three or four, to thirty or forty, but usually about ten in number are born, tail first, and begin the new generation.

Certain individuals of the paedogenetic form, however, do not develop embryos, and of these many die apparently barren, but others void, through the vulva, instead of several migratory or "caraboid" young, a single large, soft, oval egg which adheres to the side of the mother and hatches in eight or ten days into a first stage larva utterly unlike the previous forms and which much resemble a weevil larva in appearance. This larva puts its head into the vulva of its mother and feeds on the contents of her body, growing rapidly and looking like the larva of a hymenopterous parasite. When full fed it changes into another form of larva having short, stumpy, three-jointed legs, and later pupates. It now appears that only male imagoes develop out of this metrophagous larva from the uni-oviparous paedogenetic form, and that only female imagoes develop direct from pupae out of the cerambicoid larvae.

According to common knowledge it is expected that the female after mating will lay eggs (few in number and of large size as in other paedogenetic species) which will hatch into first stage larvae (probably different from either of the other first stage larvae that have been mentioned), and that these will moult into feeding larvae that may or may not be the feeding larvae preceding the paedogenetic form. The whole may be better understood by combining the known and the unknown forms in a diagram. (See accompanying plate.)

It is believed that the observations on which the above scheme is based were on individuals behaving in their normal and regular manner; that males only are developed from the mother-devouring curculioid larva hatching from the single egg of the oviparous paedogenetic form, and that the amount of animal food taken by the young caraboid larvae in feeding after birth upon the body of their viviparous paedogenetic mother may govern the development of females or the oviparous paedogenetic form instead of viviparous paedogenetic individuals. Other factors, however, must of course play important parts and it is quite possible that a change of the wood to a dryer, warmer condition may force a majority of the developing brood of feeding larvae out as females.

The provision against inbreeding before alluded to as the series of interpolated larval stages of the male should be better explained. The cerambicoid larva, to produce a female, simply

changes to pupa and issue very shortly as adult ♀; while one that will produce a male must become in sequence:—uni-oviparous paedogenetic form,—egg,—curculioid 1st larva,—metrophagous larva,—short-legged prepupa,—pupa, and adult ♂. By this time all of his sisters will have lived their short lives and died.

A detailed account of one of the most significant series of observations in which the progeny of one paedogenetic mother developed to reproduce by all three methods above shown, may put the matter in a clearer light to the reader.

A colony of larvae was found in a pine log at Natural Bridge, Ky., in September, 1912, by Mr. T. E. Snyder, who gave some fragments of wood containing cerambicoid larvae to the writer on January 3, 1913. These were placed in a plaster cell and on February 8 the colony was found to be maturing into paedogenetic individuals. From these latter a number of isolations were made, and one large community cell was started of the progeny found in the cell of a paedogenetic mother whose shrunken body had probably been consumed by the young as has since been almost proven to be the rule. These twenty-one, first-stage, legged larvae were placed in a plaster cell in a tin box and supplied with food in the form of fragments of decaying wood from an oak stump in which the writer had failed to find evidences of this species. In an hour the larvae had all disappeared but later one was found dead with the fungus disease (?) that causes these larvae to turn pink, die, and then throw out fine radiating white filaments for nearly a millimeter in all directions. Some others probably died early. After two months some of the chips were broken up and larvae of about 3 mm. in length were found. Luckily, on July 1st, almost five months after starting the breeding cell the contents were carefully examined. Sixteen of the original twenty-one were found in the following conditions:

Seven were full-fed larvae, in two of which the paedogenetic form could be seen ready to moult.

Four were in the paedogenetic stage but did not display embryos within body and subsequently died (apparently barren).

Two were represented only by the cells in which the

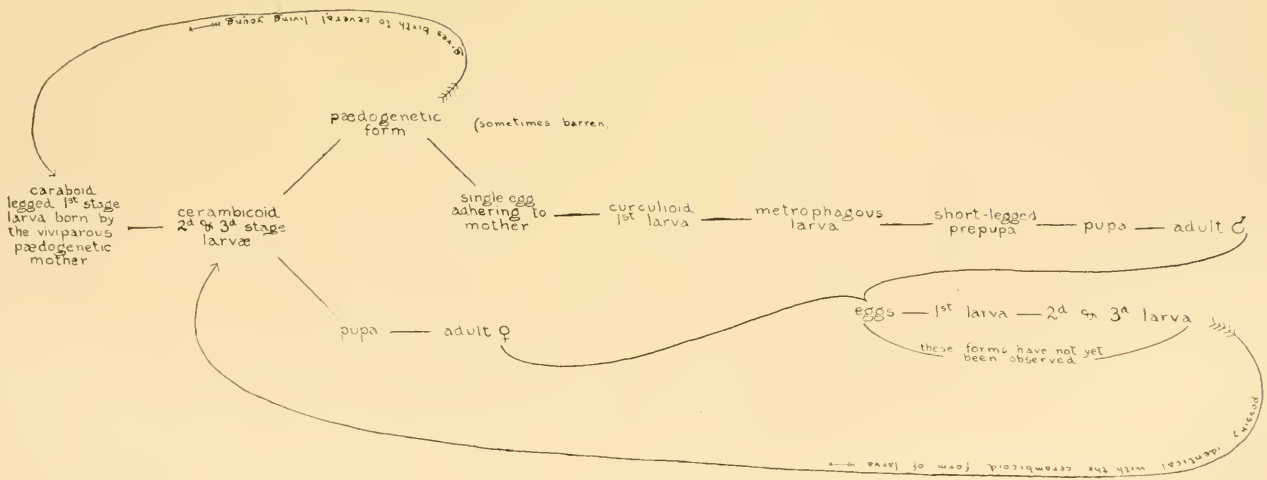

Diagram to illustrate the life-history of *Micromalthus debilis* Lec.

paedogenetic form had developed, given birth to young and been consumed by them; six young being in one cell and seven young in the other.

Two paedogenetic individuals had each laid an egg which was adhering to the side of the body.

One had transformed to the pupa of the adult ♀.

The cells of the pupa and one of the oviparous paedogenetic individuals were less than 3 mm. apart and in wood of the same character of decay, which fact would appear opposed to the idea of food differences controlling development unless early in their history.

Of the above, some were preserved, some died, the young were placed in new cells with pulverized wood to try to raise them. The pupa transformed to an adult female which lived about five days and died unmated. One of the two paedogenetic individuals with attached egg rubbed the egg free and the latter was lost in the wood debris; next day the other specimen had two adhering bodies—one egg and one young curculioid larva, the latter being in the position on the mother in which her first egg had been. The new egg may have been the one lost by the other reproductive individual, or may have been a second egg laid by the one who carried it. At any rate the first larva had the advantage, and the next day the rival egg had disappeared (supposed to have been eaten); the larva had its head in the vulva of the mother and was growing rapidly, feeding on the contents of her body, but later, when full-fed, became a victim of mould and died.

As stated in my former paper, this species should form the type of a new family, the *Micromalthidae*, abundantly distinct from the Lymexylonidae as is evident by the exceptions noted in LeConte and Horn's attempt to include it in that family in their "Classification" (Smithsonian Misc. Coll. 507, 1883, p. 231). The genus and species are well described by LeConte (Proc. Amer. Philos. Soc. XVII, 1878, p. 613) and as the family is monotypic, hardly more than the citation of the type genus is necessary. The feeble and ill-developed condition of the species was thought by LeConte to explain the simplification of structure and thus eliminate from consideration some of the structures used for classification. Hence, no doubt, the excep-

tions noted in the "Classification." To what extent it is proper to ignore or use for classification, characters developed by a species and by which it has adapted itself to a peculiar mode of life is a matter for much thought. Often the most obviously distinct characters are of recent development and trifling importance.

The family may, however, be temporarily characterized as follows:

Adults of small size, sexes similar, elongate, slender, depressed, feebly chitinized. Facies of a small *Hydnocera*. Head horizontal, wider than pronotum, narrower than humeri; eyes sub-globular, prominent; antennae widely separated, short, 11-jointed; joints 1 and 2 large, sub-globular; 3d and 4th small, globular; 5th to 10th gradually increasing in width and becoming transverse; 11th elongate, oval; mandibles strong, prominent, tridentate; maxillary palpi simple in both sexes, 4 jointed, last joint almost as long as preceding three; gula wide, indistinctly margined by externally arcuate lateral sutures. Prothorax shorter than head, side margins obsolete; prosternum not limited laterally, but transversely convex to dorsum, front margin straight, hind margin feebly arcuate between coxae which are open and contiguous; metasternum comprising about one-third the length of the body. Abdomen composed of 6 free ventral segments in the ♀, 7 in the ♂, of which the last is short and narrow. Legs short, tibiae with rather strong spine, 5th tarsal joint only a little shorter than the four preceding.

Male.—Antennae narrower, ventral abdominal segments 3, 4 and 5 with large median gland pore out of which project numerous hairs.

Female.—Antennal joints 5–11 wider; ventral abdominal segments 1 and 2, feebly chitinized; two anal processes acute, divergent and pointing downwards.

The writer hopes to give a complete account of the extraordinary life-history of this beetle at a later date.