PSYCHE.

THE PRIMITIVE NUMBER OF MALPIGHIAN VESSELS IN INSECTS. — VI.

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HYMENOPTERA. According to Schindler the number of Malpighian * vessels in the imagines of Hymenoptera varies from 12 to upwards of 150. The number 12 was observed in Myrmica, the greater number in Apis.† In certain ants according to Adlerz ‡ a very small number is observed, the neuter of Tomognathus having only 6 vessels.

Embryology shows conclusively that none of these numbers (excepting perhaps that of Tomognathus) are to be regarded as primitive. Bütschli§ found only 4 vessels in the embryo of the honey-bee (*Apis mellifica*) and Carrière‖ gives the same number for the wall-bee (*Chalicodoma muraria*). This number is retained during larval life, as has long been known (see Leuckart's figure in Lang's Vergleichende anatomie, p. 476). According to Carrière the Malpighian vessels of Chalicodoma arise as two pairs of invaginations on the caudal plate (which is an extension of the ectoderm behind the eleventh abdominal segment). In his first account they are said to arise "ehe die einsenkung des hinterdarmes beginnt; ihre mündung wächst mit dem boden bez. dem rande des hinterdarmes nach dem hinterende des mitteldarmes zu."

Adlerz* claims that the larvae of ants have 4 Malpighian vessels. It is more than probable that this is the number formed in the embryo.

It appears that we have no cases among Hymenoptera with 6 Malpighian vessels in the embryo and only 4 in the larva. On the supposition that 6 is the original number we must therefore conclude that a pair of tubules has been suppressed in the ancestral Hymenoptera. It must, however, be borne in mind that we have no observations on the embryonic development of the excretory

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* l. c. p. 635 et seq.

† The numbers given by Schindler run as follows
Formicidae.
Myrmica 12.
Formica pubescens 25–30.
Formica rufa 16.
(Adlerz gives 20 for *F. rufa* and Camponotus.)
Ichneumonidae..
Microgaster 15 (Dufour).
Chelonus, more than 20 (Dufour).
Ophion merdarius, about 40.
Some other Ichneumonids more than 40.
Cynipidae, at most 20–25.
Chrysididae, about 100
Crabronidae, *Vespidae*, *Apidae*, } more than 100.

‡ Myrmecologiska studier. 2. Svenska myror och deras lefnadsfürhållanden. Bih. svenska. vet. akad. handl. bd. 11, no. 18, 1887.

§ l. c.

‖ Die entwicklung der maurbiene (Chalicodoma muraria, Fabr.) im ei. Arch. f. mikr. anat. bd. 35, heft 2, 1890.

* l. c.

organs of the Tenthredinidae, a family which promises to throw considerable light on the ancestral peculiarities of the order.

DIPTERA. In these very highly modified insects the number of Malpighian vessels shows a constancy that contrasts strikingly with the variations occurring in the Hymenoptera; with very few exceptions the Diptera have in all their stages only 4 urinary tubules. Still there seems to be considerable variation in the manner of their opening into the intestine. Schindler* claims that in Aphaniptera, Pupipara, Tipulidae, Asilus, Haematopota, Eristalis, each of the vessels has a separate opening. In Hippobosca, Musca, Sarcophaga, Anthrax, Conops, Oestrus and Syrphus, the vessels are united in pairs and open by means of two ducts, a condition which reminds one of the Gryllidae. In Tipula and Ctenophora the terminal ends of the vessels are fused in pairs.

There is, I believe, some evidence in favor of the view that 4 is not the primitive number of vessels in the Diptera, and that there has taken place throughout the group a reduction similar to what was observed in Melolontha. I base this conclusion on an observation first made by Voeltzkow† and more recently confirmed by Graber.‡ Voeltzkow describes and figures 3 pairs of tubular diverticula to the proctodaeum of Musca. Two of these pairs he designates as Malpighian vessels, to the third pair he refers as "neuauftretende gänge." Graber's fig. 76, taf vii, shows that one of the "gänge" arises between the two Malpighian vessels on either side. Why may not this median pair of diverticula, which are apparently purely embryonic structures, represent a third pair of Malpighian vessels?

There is also another fact which vaguely points to a primitively hexanephric condition in the Diptera. I allude to Culex and Psychoda, forms which, according to Dufour* Raschke† and Schindler‡ have five Malpighian vessels. This number, which, to my knowledge, has been observed in no other insects, may have originated from the hexanephric condition either by the suppression of a single tubule or by the fusion of a pair of tubules into one. That the latter is probably not the case follows from Schindler's statement: "Dass das 5 gefäss nicht etwa das product der concrescenz zweier gefässe ist, scheint mir zur genüge daraus hervorzugehen, dass ich bei kleinen und kleinsten larven, bei der puppe und dem imago von *Culex pipiens* und *C. annulatus* immer 5, in ihren längs- und breite-dimensionen einander vollständig

* l. c. p. 642 et seq.

† Entwickelung im ei von Musca vomitoria. Arb. zool. zoot. inst. Würzb. bd. 9, heft. 1, 1889, p. 32.

‡ Vergleichende studien über die embryologie der insecten u. insb. d. Musciden. Denkschr. math. wiss. classe k. akad. wiss. Wien. bd. 56, 1889, p. 37–38.

* Mémoire sur les vaisseaux biliaires ou le foie des insectes. Ann. sci. nat. 2° sér. tom. xix, 1843, p. 166.

† Die larve von Culex nemorosus. Ein beitrag zur kenntniss der insecten-anatomie u. histologie. Arch. naturg. 53 jahrg. 1887.

‡ l. c. p. 642.

gleiche harngefässe vorfand." It is perhaps worthy of note that this pentanephric condition obtains in Diptera which are by common consent among the most ancient and primitive of the order.

The foregoing remarks may be summarized as follows:—

1. It is very probable that the so-called Malpighian vessels of Crustacea and Arachnida are not the homologues of the *vasa Malpighi* of the Eutracheata (Insects and Myriopods).

2. The Malpighian vessels of the Eutracheata arise as paired diverticula of the hind-gut and are, therefore, ectodermal.

3. In no insect embryo are more than 6 vessels known to occur; although frequently only 4 are developed.

4. The number 6 occurs either during embryonic or post-embryonic life in members of the following groups: Apterygota, Orthoptera, Corrodentia, Neuroptera, Panorpata, Trichoptera, Coleoptera, Lepidoptera and Hymenoptera.

5. The number 4 seems to be typical for the Corrodentia, Thysanoptera, Aphaniptera, Rhynchota, Diptera and Hymenoptera.

6. The embryonic number in Dermaptera, Ephemeridea, Plecoptera and Odonata has not been ascertained, but will probably be found to be either 4 or 6.

7. There is evidence that in at least one case (Melolontha) the tetranephric is ontogenetically derived from the hexanephric condition by the suppression of one pair of tubules.

8. It is probable that the insects which never develop more than 4 Malpighian vessels have lost a pair during their phylogeny.

9. The post-embryonic increase in the number of Malpighian vessels in some orders (Orthoptera, Odonata, Hymenoptera) is secondary and has apparently arisen to supply a demand for greater excreting surface.*

*There is a curious analogy between the excretory organs of these insects and the mesonephros of some vertebrates, where a second, third, etc., generation of tubules is added to the primitive metameric series. When the embryonic number of Malpighian vessels persists in insects, the demand for greater excreting surface is supplied by a lengthening of the individual vessels.

NOTE ON A SCUTELLERID ON NATIVE TOBACCO IN ARIZONA.

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At Cedar Ranch, Arizona, which is the half-way station on the stage route from Flagstaff to the Grand Cañon, I found on July 6, 1892, a scutellerid in numbers on a species of native tobacco, *Nicotiana* sp. probably *attenuata*. This locality is also called Hull Spring, and is on the edge of the somewhat mountainous country which lies to the south of it, a more or less level plateau extending to the north between it and the cañon. The native tobacco upon which the insects were found grew in patches about the spring, which is