Haploidy as a Factor in the Polymorphic Differentiation of the Hymenoptera

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Polymorphism, or the existence within a species of two or more adult forms of the same sex, is characteristic of many insects. In the Hymenoptera, polymorphism appears to be an effect of nutritional differences which occur during ontogeny (*13, 14, 16*).

The degree of polymorphic differentiation apparently varies with the developmental stage in which differentiation is induced. Differentiation induced during the larval stage, as in the honey bee (*16*), and *Melittobia chalybii* (*14*), is much less marked than that induced earlier in development during the primordial germ cell stage, as is apparently the case in the alternating generations of the gall wasps (*Cynipidae*) (*7, 9*).

Polymorphism plays an important part in the economy of a species when it forms the basis of a social organization, as in the aculeate Hymenoptera and the Isoptera (*Termitidae*).

In the Hymenoptera, however, the occurrence of polymorphism is limited by haploidy, a phenomenon unknown in the Isoptera, in which the sexes are diploid and equally polymorphic (*10*). In the Hymenoptera only the female is normally diploid, and polymorphism is largely limited to that sex. This is not because haploidy in itself is inimical to polymorphism, for species exist in which polymorphism is limited to the haploid male (*1, 13*).

It would appear that the relatively low incidence of male polymorphism in hymenopterous species is an effect of the male not being subjected to the conditions which cause polymorphic differentiation or, if so subjected, of not being able to reach maturity.

Haploidy is known to be lethal in several species of parasitic Hymenoptera (*11, 12, 15*), nonpolymorphic as well as polymorphic. It is significant that haploidy appears lethal only in species which show a disinclination to oviposit before mating (*5*).

In most species that oviposit as readily before as after mating haploidy is rarely, if ever, a factor in the failure of the egg to hatch. It is evident, therefore, that haploidy may be lethal only if it is associated with some condition of the egg brought about by the disinclination to oviposit.

Most Hymenoptera are highly specialized in their selection of sites for the deposition of their eggs. Consequently, it is not surprising that in many species of Hymenoptera, particularly in those in which the female is long-lived, oösorption occurs if suitable oviposition sites are lacking (*4*). When the rate of egg deposition is relatively low, a relatively high proportion of the eggs deposited may be partially absorbed. In a mated female such eggs are more likely to be fertilized than eggs deposited rapidly and not subjected to the oösorptive process.

Whiting (*17*) has observed that in *Microbracon hebetor* more nonhatching eggs were obtained from females mated with related males than from females unmated or mated to unrelated males. The higher mortality of the eggs from the close-crosses in *M. hebetor* is reported by Whiting as due to the lower viability of the diploid individuals. Since it is quite possible that females mated with related males are more disinclined to oviposit than females mated with unrelated males, the former may deposit more partially absorbed diploid eggs than the latter. Such eggs may account for the polymorphism exhibited by inbred stocks of *Microbracon* (*6*).

In species in which the unmated female is disinclined to oviposit, the haploid male progeny are produced the greatest numbers when oviposition by mated females occurs at the maximum rate. It is then that the highest proportion of eggs escape fertilization and oösorption is at a minimum (*2*).

If the haploid hymenopterous egg, upon losing part of its content by absorption while in the ovariole, loses its capacity for hatching, it may regain this capacity by becoming diploid through fertilization. This probably would be necessary if polymorphic differentiation is determined by the partial absorption of ripe ovarian eggs (*8*).

In this connection it should be noted that in polyembryonic species it may be the mere addition of sperm to an egg that enables that egg to produce more embryos (*3*) than it would if unfertilized.

It is significant that in endoparasitic species—that is, species which place their eggs in position to absorb nutrient from the host—polymorphism appears to be limited to the haploid individual (*1, 13*). It is known in the case of the endoparasitic *Trichogramma semblidis* that polymorphic differentiation is determined by the kind of host.

Polymorphic individuals in species in which differentiation is determined by the partial absorption of the ripe ovarian egg (which is a point about midway in ontogeny) should be more strongly differentiated than the queen bee and worker and less so than the alternating generations of certain gall wasps. The oösorptive process apparently has a graduated effect on the eggs which would allow for the fullest expression of the polymorphic potentialities inherent in the germ plasm.

In the Hymenoptera, polymorphism finds expression commonly in diploid individuals, rarely in haploid individuals. In many, if not all, polymorphic species, under natural conditions, the production of diploid eggs greatly exceeds that of haploid eggs.

In social species the low incidence of male polymorphism may result either from the mortality of the partially absorbed unfertilized egg, from the fertilization of all the partially absorbed eggs deposited, or from the relatively small nutritional needs of haploid individuals.

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Carcinogenic Substances From Pituitary Glands of Cattle

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The discovery of carcinogenic chemical substances suggested that in certain conditions analogous substances are produced within the organism and thus become responsible for cancerous growth.

Schabad (*12, 14, 15*) obtained a lipid extract from the liver of a patient who died of stomach cancer, and this extract, when injected into white mice, induced malignant tumor growth in some of the animals treated.

In further investigations Schabad, *et al.* (*4, 5*) prepared extracts of human livers from cancerous as well as noncancerous individuals. Of the white mice injected with these extracts about one-third died within the first few months of the experiment. A number of animals which lived to an age of more than 8 months following the first injection developed malignant tumors.

The findings of Schabad were confirmed by other investigators (*1–3, 13, 16–19*).

It must be added that Menke (*10, 11*) injected lipid extracts from human mammary cancers into white mice, and of 36 mice injected, 7 developed sarcomas after 7 to 14 months.

The above experiments indicate that carcinogenic chemical factors of a lipid nature are present in the cancerous as well as in the normal organism. Thus, the question arises as to the origin of these substances.

For investigation of this problem we employed our previous studies, which indicate that the pituitary gland is connected in a hormonal way with the development of cancer (*6, 7*). We therefore examined extracts of the pituitary gland for presence of carcinogenic hormonal factors.

Experimental

In our experiments fresh pituitary glands from cattle were freed from adjacent tissues and the anterior and posterior lobes of the gland carefully separated. One hundred posterior lobes or 50 anterior lobes were used for the preparation of each lipid extract.

The glands were extracted with acetone, ethyl ether, and alcohol, and the brownish oil obtained was suspended in sweet almond oil and injected subcutaneously into white mice of our own breeding. Our purebred strain of mice has a low incidence of spontaneous tumors (two mammary tumors in 1,700 mice).

The amount of extract obtained each time varied from 300 to 800 mg. The animals received 10 to 30 mg. each as a single injection, no difference in the effects being noted with variation of the dose within these limits.

Four extracts were prepared from the anterior pituitary, and 32 white mice were given a single injection of the extracts.

Seven mice died during the first 4 months of the experiment. Of the remaining 25 animals injected with the anterior lobe extracts, 9 developed malignant tumors: 4 females developed breast cancer (after 7, 7, 10, and 14 months), 1 male and 1 female developed carcinoma at the site of injection (after 13 and 6 months), 1 male and 2 females developed liver cancer (after 8, 9, and 8 months).

Of the 16 animals which died without developing tumors, the individuals survived as follows: 3 for 7 months, 3 for 8 months, 2 for 10 months, 1 for 11 months, 2 for 12 months, 3 for 13 months, 1 for 14 months, and 1 for 19 months.

Of the four extracts prepared from the anterior lobe, one caused no malignancy in the animals injected, while another provoked 5 various tumors in 6 injected mice. The remaining two extracts provoked malignancy in 20.6 per cent of the animals injected.

Five extracts were prepared from the posterior lobe of the pituitary gland, and 35 animals were given a single injection of the extracts.

Twelve mice died during the first 4 months of the experiment. Of the remaining 23 animals injected,