THE OCCURRENCE OF THE HUMORAL CHROMATOPHORE ACTIVATOR AMONG MARINE CRUSTACEANS, AND ITS EFFECT UPON THE CHROMATOPHORES OF CRUSTACEANS, FISHES, AND AMPHIBIA

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The blood of crustaceans carries a chromatophore-activating principle, as announced in 1928 by Koller and by Perkins, working independently. The eye-stalks of *Palaemonetes* was found by Perkins to produce this humoral substance, and confirmed by Koller on *Crangon* and several species of *Leander*. It has since been found in *Macrobrachium* by Smith (1930), in *Praunus* by Koller and Meyer (1930), and in *Callinectes* by Perkins and Kropp (1932). The further interspecificity of the crustacean eye hormone was reported by Koller and Meyer (1930) and by Meyer (1931), who injected eye extracts into the fishes *Gobius* and *Pleuronectes*, producing chromatophore movements. Perkins and Kropp (1932) reported melanophore changes in tadpoles of *Rana* following the injection of eye extracts from *Callinectes* and from *Palaemonetes*.

Already indicated as present in several families of decapods, the hormone was looked for in as great a variety of crustaceans as could be obtained at Mt. Desert Island. We had available seven species of marine crustaceans belonging to as many different families. Six were decapods,—*Crago (=Crangon) boreas, Pandalus montagui, Homarus americanus, Pagurus longicarpus, Libinia emarginata*, and *Cancer irroratus;* one was a schizopod,—*Mysis stenolepis.*

The eyes were extracted in sea-water, as has been described previously, and injected into those of the crustaceans which undergo readily observable color changes, and into species of fishes and amphibia.

Using *Crago* as a test animal to determine the effectiveness of the eye extract in producing chromatophore movements, measured amonts of the extract in question were injected into two sets of *Crago* which had previously been adapted to white and black backgrounds respectively. In all cases the chromatophores were examined microscopically before and after injection. Suitable controls received like amounts of sea water or muscle extract.

Having found an eye extract to contain the chromatophore-activating substance, it was injected into the various crustaceans, fishes, and amphibia at hand.

RESULTS

Crustaceans: Every extract of eye-stalks tested induced a condition in black-adapted *Crago* indistinguishable from the white-adapted state. The effect on the white-adapted animals was to increase the degree of chromatophore contraction already present. Control animals, whether treated with sea-water or muscle extracts, showed no comparable effects and in most cases were wholly unaffected. Wherever possible, limitations being imposed by the fragility and lack of resistance to laboratory conditions of certain of the crustaceans, or to lack of response to backgrounds under normal conditions, the eye extract of each crustacean was injected into all the others with the same result, viz., varying degrees of chromatophore contraction.

It was a remarkable thing to find, as we had in the case of *Callinectes,* that decapods which do not ordinarily show adaptive color changes or any chromatophore movements at all in response to backgrounds *(Homarus, Libinia, Pagurus)* all possess the active principle in their eye stalks. The hormone of such crustaceans was found to be effective in producing chromatophore movements not only in other crustaceans, but in fishes and amphibia as well.

Fishes: Concerning the reaction of fish chromatophores to the crustacean eye hormone, we found, as Koller and Meyer had, that the chromatophores contract following subcutaneous injection of the crustacean eye extract. The same general technique as to preparation of the extract, adaptation of the recipients to appropriate backgrounds, and use of controls was followed as in the experiments with crustaceans.

The eel, *Anguilla rostrata,* shows the usual reaction to backgrounds, but this reaction is relatively slow. Its response to *Crago* eye-extract is likewise slow, but positive. In three to five minutes after injection, black-adapted eels showed a slight general melanophore contraction, somewhat more marked in the region around the place of injection. The effect obtained was transient and after ten or fifteen minutes the animals reverted to their original states.

The herring *Clupea harengus* showed only a local effect following injection of eye extract. This was evidenced by the appearance of the blue-green coloring around the place of injection and lasted for about ten minutes. A somewhat similar effect was produced by injecting sea water, but much more slowly and with considerable mottling of color. There was never the sharp response as there was to eye extract. In no case was the effect seen all over the body.

The pollack, *Pollachius virens,* adapts only slightly to backgrounds after prolonged stay, and responds not at all to eye extract. Doses of twenty *Crago* eye-stalks failed to induce an effect in either black-adapted or white-adapted pollacks.

Although the mackerel, *Scomber scombrus,* shows a marked difference between the white-adapted and black-adapted states, like the pollack, it did not respond to crustacean eye-stalk extracts.

Fundulus heteroclitus reacted well to several crustacean eye-stalk extracts. Small doses brought on local contraction of melanophores (following an initial expansion due to nerve stimulation by the needle), while large doses produced varying degrees of general pallor as a result of melanophore contraction.

The sculpin, *Myoxocephalus octodecimspinosus,* adapts very readily to backgrounds and also responds to crustacean eye-stalk extracts by definite contraction of melanophores. The response was always general and unmistakable. During the time that the extract was effective there was complete loss of ability to adapt to backgrounds. The controls showed no response, behaving as do normal, non-experimental individuals.

The common dab, *Limanda ferruginea,* adapts to backgrounds, although not with the same readiness as do other flatfishes. It reacted to injection of eye-extract by local contraction of melanophores, both around the site of injection and at various parts of the body.

Amphibia: the tadpoles of *Rana clamitans* were described as responding to injection of *Palaemonetes* and *Callinectes* eye-stalk extracts by Perkins and Kropp (1932). In repeating these experiments with extracts from *Pagurus* and *Homarus* effects identical with those previously described were obtained, namely, maximum expansion of melanophores. Extract of two eyes of either of these crustaceans was sufficient to induce melanophore expansion in white-adapted tadpoles five minutes after injection.

SUMMARY

There is wide interspecificity in the action of the crustacean eye-hormone. Determination of its range of effectiveness has been extended to include sixteen species of crustaceans representing eight families of decapods and one schizopod. Contraction of chromatophores in crustaceans always follows injection of the eye extract.

The ability of the crustacean eye hormone to produce chromatophore changes is seen to extend into the vertebrates, as evidenced by the contraction of chromatophores in fishes and expansion in amphibia.

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THE INTERNAL PRESSURE OF CUCUMARIA FRONDOSA

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In holothurians containing cuverian organs a rise in internal (body cavity) pressure may be associated with the discharge of those organs. In the case of *Holothuria nigra,* Mines (1912) found that the pressure needed to produce elongation of these organs was 20 to 30 c.m. of water. *Cucumaria frondosa* lacks cuverian organs and in this animal increased internal pressure is accompanied only by expulsion of water from the body cavity, contraction of body wall musculature