METECDYSIAL MOLT STAGING AND CHANGES IN THE CUTICLE IN THE CRAYFISH ORCONECTES SANBORNI (FAXON) 1)

BY

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INTRODUCTION

It is well known that every crustacean periodically secretes a new exoskeleton and sheds the old. This cycle of repeated secretion and shedding was divided by Drach (1939) into a series of stages that can be recognized by external examination of the animal. Drach developed his criteria for recognizing the different stages by a study of several brachyuran decapods. Some of these criteria can be applied directly to any crustacean, and some can not. The criteria that can be applied universally are those that depend on some discrete event that occurs universally: formation of new setae, secretion of enough new cuticle to be visible to the naked eye, opening of the line of dehiscence before ecdysis, ecdysis, and completion of the innermost, membranous layer of the cuticle. The specific criteria that apply only to the crabs studied by Drach are mostly ones that depend on progressive increase in rigidity of different parts of the integument as the new cuticle thickens and hardens after ecdysis. Because the spatial patterns of thickening and hardening are different in different crustaceans, a different set of criteria must be developed for each genus, and perhaps for each species. In 1944, Drach described such a set of criteria for recognizing his stages in a natantian decapod, and a number of workers have since described criteria for other crustaceans, including additional Natantia and Brachyura and also members of the Anomura, Macrura, Amphipoda, and Isopoda (Hiatt, 1948; Charniaux-Legrand, 1951; Kincaid & Scheer, 1952; Charniaux-Cotton, 1957; Scheer, 1960; Travis, 1960a, 1960b, 1965; Stevenson, 1961, 1964; Skinner, 1962; McWhinnie, 1962).

Carlisle (1960) said that because these criteria must be modified for each new species studied, the system is not generally valid. As mentioned above, the system does have general validity with respect to a few of the criteria. However, it would be considerably improved if additional criteria having universal applicability could be found. Such additional criteria for two stages are already available but have not heretofore been used. These criteria are internal events described by Drach (1939) but not used for recognizing his stages because the events

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cannot be detected externally. He said (1939: 292) that at the beginning of stage A₂, secretion of the principal layer and calcification begin and (1939: 297) an amber-colored substance is injected into the pre-exuvial layers. Second, he said (1939: 292) that chemical changes in the pre-exuvial layers are complete at the end of stage B₂. I wish to propose that these criteria be used to define the beginnings of stages A₂ and C₁, respectively. These criteria can be applied universally. It will be necessary, however, to rediscover for each species what external changes are occurring at the same time as these internal changes so that the stages can be recognized externally. For example, in one species, stage A₂, that is, the time when secretion of the principal layer begins, etc., may be recognized by loss of flexibility of the pereiopods, and in another species it may be recognized by loss of flexibility of the rostrum.

With the addition, then, of stages A₂ and C₁, the following are the metecdysial (postmolt) stages that can be determined by universally applicable criteria. After each stage, the criteria that determine the beginning of that stage are given. Stage A₁: ecdysis. Stage A₂: secretion of post-exuvial endocuticle (principal layer) and calcification begin, and material is added to the pre-exuvial layers. Stage C₁: chemical changes in the pre-exuvial layers are complete. Stage C₄*: secretion of the principal layer is complete and secretion of the membranous layer begins (after Drach, 1939: 310). Stage C₄: secretion of the membranous layer is complete. No universal criteria are available for determining the beginnings of stages B₁, B₂, C₂, and C₃, and criteria for these stages must be decided arbitrarily for each species.

The aim of the study reported here was to find criteria suitable for defining the metecdysial stages in the crayfish *Orconectes sanborni* (Faxon) for use in future studies on metecdysial phenomena. Criteria for defining proecdysial (pre-molt) stages in *Orconectes* are described in another publication (Stevenson, Guckert, & Cohen, in press). Two investigators (Travis, 1960b; McWhinnie, 1962) have already developed criteria for recognizing metecdysial stages in another species of *Orconectes*, *O. virilis* (Hagen). One of them, McWhinnie (1962), published a partial description of her criteria, as follows: at stage B only the rostrum and cephalic carapace are slightly firm, and an increase in firmness of the rostrum, cephalic carapace, chela, pereiopods, and branchiostegites permits the designation of stages C₁ and C₂.

**MATERIALS AND METHODS**

Crayfish of the species *Orconectes sanborni* were collected in Plum Creek and in the Cuyahoga River near Kent, Ohio, U.S.A., and maintained in the laboratory as described previously (Stevenson, Guckert & Cohen, in press). Animals of both sexes and of all ages collected older than six months were used. Their carapaces ranged from 1.4 to 3.1 cm in length. After each animal molted, the progression of changes in hardness of its carapace was followed, and the postmolt period was