

Stomach and gut contents of *Carapus mourlani* from starfish and a holothurian

V. B. MEYER-ROCHOW

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No echinoderm tissue was found in any of the eight fish recovered from coelomic cavities of cushion starfish, but the intestine of the fish contained well-digested traces of crustacean material. Of the seven fish collected from a holothurian host species, five had empty stomachs, but two contained semi-digested parts of a small brachyuran crab and a small carapid fish, whose position in the stomach indicated that it had entered tail first. The guts of all specimens contained fragments of crustacean material, bristles (probably of polychaete origin) and an amorphous orange substance. Although the results do not completely rule out parasitism for *C. mourlani*, it seems likely that both nocturnal foraging and the habit of residing inside echinoderms and other suitable hosts have evolved primarily as means for obtaining protection from diurnal predators and that any possible parasitic activity of the fish has evolved secondarily.

V. B. Meyer-Rochow, Department of Physiology, University of Oulu, Kajaanintie 52, SF-90220 Oulu 22, Finland (on leave from the Department of Biological Sciences, University of Waikato, Hamilton, New Zealand).

1. Introduction

Fishes belonging to the family Carapidae are noted for their unusual behaviour and have attracted the attention of natural historians, ichthyologists and physiologists for a long time. They are popularly known as assfish or pearl-fish, and are inquiline or intestine fish. These slender fish, usually less than 25 cm long, live in the coastal waters of all warmer seas and have been collected from sessile tunicates, the mantles of large bivalves, and the coeloms of starfish and holothurians. On the basis of morphological and ecological features, the family Carapidae is included in the sub-order Ophidioidea, which is placed with the gadiform fishes.

During the 1975 "Alpha Helix" South East Asia Bioluminescence Expedition 34 carapid fish, identified as *Carapus mourlani* (Petit 1934), were collected in the South Moluccan Sea. This species has been found more regularly in asteroids than in holothurians (Mortensen 1923; Trott 1970; Jangoux 1974), but in one case 15 individuals were obtained from a single holothurian (Meyer-Rochow 1977a).

Why and how the relationship between cara-

pid fished and their hosts evolved is unknown, but interactions between these two animal groups have repeatedly been termed 'commensalism', 'parasitism' and 'inquilinism'. Possibly there may even be a symbiotic relationship, the fish leaving its host periodically to feed upon the ectoparasites of the latter. (The small shrimp *Periclimenes soror* was regularly found on the cushion starfish *Culcita novaeguineae*, which is the principal host of *C. mourlani* in the Moluccan Sea.)

To determine accurately the particular type of fish/echinoderm association that exists for each carapid species, a knowledge of the fish's movements in and out of its host as well as observations on the fish's diet are required. Data of this sort, however, are lacking for most carapids, as prolonged direct observations on feeding behaviour, food uptake and composition are difficult and often impractical to make (the fish may not leave its host for several days).

As a contribution to the discussion of carapid biology, it therefore seemed a more useful and promising exercise to compare stomach and gut contents of fish recovered from different hosts. Our *C. mourlani* specimens were obtained

from both starfish and holothurian hosts during April at approximately 4°32.5'S; 129°54'E (for more collection data such as depth, size of hosts, etc., see Meyer-Rochow 1977a).

2. Results

Eight specimens obtained from the cushion starfish, *Culcita novaeguineae*, were dissected. All had contracted and empty stomachs. The intestine was also empty or contained well-digested traces of crustacean material. No echinoderm tissue was found in any of the fish examined. Five of seven specimens recovered from the holothurian *Bohadschia argus* had empty and rather contracted stomachs. The other two contained semi-digested parts of a small brachyuran crab (cephalothorax and distal ends of pereopods) and a small carapid fish, which was half-digested. The position of the latter in the stomach indicated that it had entered the oesophagus tail-first.

The guts of all seven specimens contained an amorphous orange material (crustacean pigments?) within which fragments of crustacean exoskeleton, cephalothorax, pereopods, tergites and abdominal sternites were discernible. Also recognisable were more or less empty shells of stalked compound eyes as well as large numbers of bristles, possibly of polychaete origin.

3. Discussion

Our results disagree with observations by Arnold (1953) and Hipeau-Jacquotte (1967), who concluded that the association between carapids and echinoderms is a parasitic one. The latter author and Jangoux (1974) reported the presence of starfish gonadal material in the stomach of *C. homei*. Our observations support Trott (1970), who found no traces of host tissue in either *C. bermudensis*, *C. homei* or *C. mourlani* and observed the uptake of small shrimps by *C. homei*.

The finding that all fish recovered from starfish hosts had empty intestines whereas those from a holothurian contained crustacean debris not only suggests that the holothurian inhabitants had obtained food more recently and more regularly than the starfish dwellers, but also

provides support for Smith's theory (Smith 1964) that *Culcita* could be the wrong host and that, once inside, *C. mourlani* had difficulty leaving it again.

The nature of the stomach and gut contents together with observations on the dentition of *C. mourlani* (Meyer-Rochow 1977b) allows one to draw the following conclusions: (a) *C. mourlani* is adapted to seize, swallow and digest large prey such as other carapids, (b) apart from cannibalism, *C. mourlani* feeds on crustaceans and polychaetes. Whether ectoparasitic crustaceans from the host echinoderm form a significant component of the diet of *C. mourlani* could not be determined owing to the advanced state of digestion of all stomach and gut material found. Equally unknown is whether the brachyuran crustacean material found in the stomach of one fish belonged to *Lissocarcinus*, a companion commensal that has been reported to live in the same host holothurian from which our carapids were obtained (Trott & Garth 1970).

Physiologically, carapids are adapted to survive long periods of exposure to the special environmental conditions (O₂ level) that prevail inside the coelomic cavities of starfish and holothurians (Seymour & McCosker 1974), but it seems likely that carapids leave their hosts at least temporarily. In spite of the dark cave-like conditions inside its hosts (for quantitative data on light transmission see Trott 1970: 31) the eyes of *C. mourlani* are not degenerated. They exhibit pupillary movements, well-developed outer segment fine structure, and a receptor/bipolar/ganglion cell ratio all of which indicate an active nocturnal way of life (Meyer-Rochow & Tiang 1978). We may therefore conclude that both nocturnal foraging and the habit of residing inside echinoderms and other suitable hosts have evolved to obtain protection from diurnal predators such as pomacentrids and other fishes.

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