Biology of *Hymenocera picta* Dana[1]

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Abstract

The marine shrimp *Hymenocera picta* Dana of the Indo-Pacific region grows up to 5 cm in length. Both sexes moult every 18–20 days. After each moult, the female is ready to spawn about 1000 eggs which become attached to the underside of her abdomen. Mysis-larvae hatch out of the eggs within 18 days. Between moulting and egg-laying the female will allow one single copulation which is good for only one batch of eggs. These shrimps are territorial (philopatric) and normally live in pairs. *Hymenocera* seem to feed exclusively on starfish; they are able to kill even large specimens. There is no obvious cooperation between the members of a pair, nor are two animals necessary to make hunting successful. Every *Hymenocera*-male has a clear preference for his individual mate with whom it stays most of the time. However, it tries to copulate with every available freshly moulted female. Since individual recognition and pair-bond do exist, this species seems to have a rather low population density which has been confirmed by field data.

For several years we have studied the painted shrimp, *Hymenocera picta* Dana (Fam. Gnathophyllidae), in 280–1 laboratory tanks. Our studies are based on shrimps and other reef animals from the East Coast of Africa between Dar Es Salaam (Tanzania) and Malindi, north of Mombasa (Kenya).

Hymenocera individuals lived about one year in our tanks; those caught when about 1 cm long grew up to 5 cm in length. Both sexes are creamy white with conspicuous blue-edged orange color patches. Adult males lack the blue tips of the pleopods, present in adult females, and have the second color patch on the side of the abdomen only weakly developed. Under laboratory conditions with a 12:12-hour light cycle, *Hymenocera* is light active. Both sexes moult every 18–20 days. After each moult, the female is ready to spawn about 1000 eggs which become attached to the underside of her abdomen. Mysis-larvae hatch out of the eggs within 18 days. From the field we got females with eggs nearly all the year round (with 4 months gap due to lack of females).

Hymenocera is territorial (philopatric) and usually lives in pairs. Its general behavior has been described by Wickler and Seibt (1970). Between moulting and egg-laying the female will allow one single copulation (see film E 1725) which is good for one batch of eggs only. Without copulation, the female wastes this reproductive cycle. In a serie of experiments, we separated the sexes to study the

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female reproductive cycle. The results show that the continuous presence of a male is not necessary for the female to produce eggs, though copulation is necessary for the female to lay eggs.

Hymenocera seem to feed exclusively on starfish; they are able to capture even large specimens. There is no obvious cooperation between the members of a pair, nor are two animals necessary to make hunting successful. The shrimp normally turns the starfish upsidedown (Fig. 1, and films E 1724 and E 1795) and then pierce its epidermis with the first pair of legs which possess sharp and tiny chelae. These pull out internal tissue which is eaten (Figs. 2 and 3, and films E 1724 and 1795).

Fig. 1. Male *Hymenocera* turning an *Oreaster* upside-down.

In the field, *Hymenocera* was found most commonly feeding on starfish of the genera *Nardoa* and *Linckia*. In the laboratory, the shrimp took every kind of starfish offered (*Linckia, Leiaster, Nardoa, Oreaster, Pentaceraster, Ceramaster*, and *Acanthaster*). From the limited number of choice-experiments so far possible, it seems that *Hymenocera* has a preference for starfish whose arms have circular cross-sections (*Linckia*-type); starfish with triangular cross-sections of their arms (*Oreaster*-type) are still readily accepted, while *Acanthaster* was attacked only by hungry *Hymenocera* that had no choice (film E 1795). Therefore, it seems highly unlikely that *Hymenocera* may be used as a biological weapon against *Acanthaster*. However, we had only *Acanthaster* of 12 cm or more in diameter available; the shrimps' reactions towards small *Acanthaster* are still unknown.

Oreaster normally lived for months in our tanks; but every individual successfully attacked by *Hymenocera* died within two days, though it would recover if

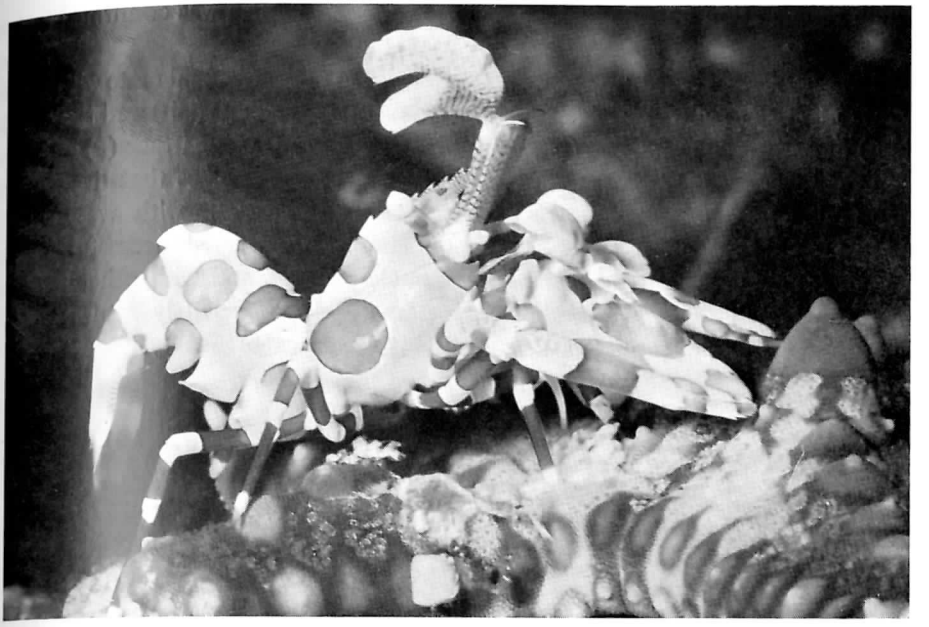

Fig. 2. Male *Hymenocera* feeding on an (upright) *Oreaster*.

Fig. 3. *Hymenocera* on its normal prey, *Linckia*.

the shrimps were taken off within the first day. Attacked *Acanthaster*, despite its high capacity for regeneration in the field, died rapidly within one day. The killing of starfish by *Hymenocera*, therefore, may be a laboratory artifact. The especial-

ly high regeneration potential of the preferred *Linckia* starfish was confirmed in our tanks.

Every *Hymenocera* male has a clear preference for his individual mate with whom it stays most of the time. Fig. 4 illustrates how often the male (left) and the female (right) of a given pair were observed sitting close to his or her partner (P) and how often they were seen close to one of the other eight conspecifics that lived in the same tank. Despite this preference, the males try to copulate with every freshly moulted female in the tank; Fig. 5 shows the number of observed successful copulations of four males with their respective female partners and with other females. Following copulation with another female, the male immediately returns to his preferred female, indicating partner-fidelity without sexual fidelity.

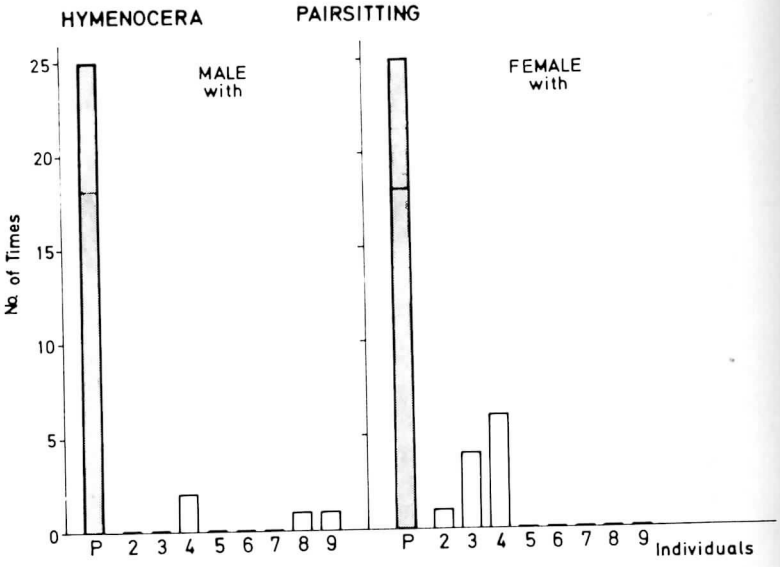

Fig. 4. Partner preference. See explanation in text.

This system of sexually non-exclusive partner fidelity ensures fertilization of the paired female every time she moults, and moreover would allow for fertilization of lone females which happen to moult close to the pair. Should this happen rather often, a pair-bond would be of little selective advantage. Since individual recognition and pair-bond do exist (Seibt and Wickler, 1972), we suggest that *Hymenocera* has a rather low population density which is confirmed by field data.

Correlations between social organization and ecology of animal species have often been suggested but not yet been sufficiently demonstrated in crustacea. The monogamous *Hymenocera* is a predator, hunting for large prey. Its closest relative, the much smaller zebra shrimp, *Gnathophyllum americanum*, which we have studied in the field and in the laboratory, parasitizes on starfish, too, but does not show obvious monogamous behavior. Another monogamous species is the banded or

cleaner shrimp, *Stenopus hispidus* (Johnson, 1969). It has not been possible, however, to test its partner fidelity, since these animals are strong fighters (see film E 1794), and not more than two paired individuals could be kept even in tanks up to 2 m^3. Monogamy has further been claimed for some *Alpheus* species (Nolan

FREQUENCY OF COPULATIONS WITH

	PARTNER	OTHER ♀♀					
		1	2	3	4	5	6
δ_7	3	1					
δ_8	6	1	1	2			
δ_9	2	2					
δ_{13}	3	1	1	2	1	1	1

Fig. 5. Number of observed successful copulations with female partner and with other females. Further explanation in text.

and Salmon, 1970), including *A. frontalis* that lives in tubes built with *Oscillaria*-algae and does feed on this algal material (Fishelson, 1966). Some of the *Periclimenes* species are typically found in pairs, too; they live with sea anemones. Another commensal of the same anemones, the porcellanid crab *Neopetrolisthes ohshimai*, a specialized plankton feeder (see film 1723) does not—according to our observations in the field and the laboratory—show any tendency towards monogamy. Strict monogamy is shown by the oniscoid desert woodlouse, *Hemilepistus reaumuri* which rears its young in closed family groups (Linsenmair and Linsenmair, 1971; Linsenmair, 1972). Thus it seems that monogamy does occur under very different ecological conditions. This does not disprove a correlation between social organization and ecology, but rather indicates our lack of knowledge of the important biological characters of most for the species in question.

Field and laboratory studies on the biology of small reef animals seem to be an important step towards our understanding of the entire reef biology and ecology. Several urgent questions could be answered if we knew the reproductive season, reproductive rate, population density, social structure, life span, preferred and normal food as well as predators and enemies, commensals and parasites of all the reef animals.

So far, we do not know the larval development of *Hymenocera* nor its enemies. If actually every female spawns about 1000 eggs every 20 days, and if nevertheless *Hymenocera* is as rare as it seems to be, there must be a rather high mortality rate during the early ontogenetic stages.

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FILMS[3]

E 1723 *Neopetrolisthes ohshimai* (Porcellanidae)—Planktonfang und Putzen. U. Seibt and W. Wickler 1971.

E 1724 *Hymenocera picta* (Gnathophyllidae)—Fressen eines Seesternes. W. Wickler and U. Seibt 1971.

E 1725 *Hymenocera picta* Gnathophyllidae)—Kopulation. U. Seibt 1971.

E 1794 *Stenopus hispidus* (Stenopidae)—Beschädigungskampf. U. Seibt 1972.

E 1795 *Hymenocera picta* (Gnathophyllidae)—Erbeuten des Stachelseesternes *Acanthaster planci*. W. Wickler and U. Seibt 1972.

[3] These films have been published through the Encyclopaedia Cinematographica and are available from the complete archives in a) Canada: Canadian Film Institute, National Science Film Library, 1762 Carling, Ottawa 13, Ontario; b) W.-Germany: Institut für den wissenschaftlichen Film, Nonnenstieg 72, D–34 Gottingen; c) Japan: EC Japan Archieves, Shimonaka Memorial Foundation, Heibonsha Building, 4 Yonbancho, Chiyodaku, Tokyo; d) USA: The Pennsylvania State University, Audio-Visual Services, 6 Williard Building, University Park, Pa. 16802.