Commemorative volume for the 80th birthday of Willem Vervoort in 1997

Observations on the symbiosis between *Colus gracilis* (Da Costa, 1778) (Mollusca: Gastropoda) and *Hormathia digitata* (O.F. Müller, 1776) (Cnidaria: Actiniaria)

R.M.L. Ates

Ates, R.M.L. Observations on the symbiosis between *Colus gracilis* (Da Costa, 1778) (Mollusca: Gastropoda) and *Hormathia digitata* (O.F. Müller, 1776) (Cnidaria: Actiniaria).
Zool. Verh. Leiden 323, 31.xii.1998: 257-262, figs 1-2.— ISSN 0024-1652/ISBN 90-73239-68-0.
Ron M.L. Ates, Govert Flinckstraat 19, 1506LL Zaandam, The Netherlands, e-mail: ronates@dds.nl.

Key words: *Colus gracilis*; *Hormathia digitata*; Gastropoda; Actiniaria; symbiosis; behaviour; shell mounting; aquarium observations.
Aquarium observations of the behaviour of the actinian *Hormathia digitata* when mounting live specimens of the gastropod *Colus gracilis* are fully described for the first time. *C. gracilis* actively initiates an association with *H. digitata* by approaching and remaining stationary near the actinian.

Introduction

Behavioural patterns displayed by different species of actinians mounting a gastropod shell are similar but not stereotyped (Ross, 1974b: 290). Similarities in behaviour may reveal a shared ancestry. Although considered to be ancestral (Balss, 1924: 778; Carlgren, 1928: 170; Ross, 1974a: 123) to the often studied hermit crab/gastropod shell/actinian symbioses, associations in which a gastropod carries one or more actinians (for a review see Ates, 1997) have only been studied in detail by Hand (1975) and by Ross & Kikuchi (1976). *Hormathia digitata* (O.F. Müller, 1776) is a well-known, non-obligate associate of live gastropods (Stephenson, 1935). Although Ross (1974a: 117) did not have individuals of *H. digitata* "available in the numbers or in the conditions necessary for a satisfactory testing of their ability to transfer from other surfaces to shells", he (Ross, 1974b: 288) described their behaviour when mounting a gastropod shell in one sentence.

Prospects of obtaining other specimens continue to look bleak and so my observations, although limited in number, are here presented as the first complete description of the behaviour of *H. digitata* when mounting the gastropod *Colus gracilis* (Da Costa, 1778).

Material and methods

In February 1983 four specimens of *C. gracilis* carrying in all five specimens of *H. digitata* on their shells were obtained from the Rijksinstituut voor Visserij-Onderzoek (RIVO) at IJmuiden (Netherlands). In October 1983 I obtained three more specimens carrying three actinians from the same source. The gastropods were 2-5 cm long (shell length) and the actinians were 1-4.5 cm column height in extension. The animals had been trawled by fisheries research vessels in the North Sea north of 55°N, from 40-50 m depth. All were kept in a well insulated aquarium (dimensions 97 × 37 × 43 cm) containing about 140 litres of sea water ($Cl^- > 16.5‰$) originating from the Ooster-

schelde estuary in the southwestern part of the Netherlands.

The cooling system of a discarded refrigerator was used to maintain a low temperature in the aquarium. In winter the aquarium temperature did not fall below 1°C. In summer (maximum outside air temperature more than 30°C) the cooler kept the water temperature below 7°C but the primitive thermostat and the underpowered cooling unit caused temperatures to vary between 4° and 7°C over periods of about 48 hours. Although the front side of the aquarium had double glazing, inspection of the aquarium contents had to be limited in order to keep the insulation in place as long as possible, specially in case of high outside air temperatures. Due to a breakdown of the cooling unit the observations were discontinued after 17 months.

All specimens of *Hormathia digitata* were detached from the gastropod shells and allowed to settle on the glass walls of the aquarium as well as on flat stone plates used for decoration. In about two months the gastropods had apparently adapted to aquarium conditions as was assumed from their taking food (mussel, fish and shrimp meat) and from their moving about in what seemed a healthy condition. Considering their behaviour no acclimatization period appeared to be necessary for the actinians. The actinians were fed the same food as the gastropods.

Results

The observations made on the behaviour of *Hormathia digitata* in its relation to *Colus gracilis* are described in several stages, as follows.

(1) Approaching.— About three months after the first animals had been transferred to the aquarium it was seen that a gastropod remained motionless at a distance of less than about 2 cm from an actinian attached to a stone plate. While situated next to the actinian the gastropod slightly tilted over and its tentacles remained in sight. It did not move at all. Three of the gastropods of the first batch and all of the second were subsequently seen to act like this. This stationary attitude of the gastropod was seen to last between half an hour and three days but may have lasted much longer. More than usual tentacular activity by the actinian was noted two times when the gastropod was beside it, but it did not result in adhesion.

(2) Tentacular adhesion.— A reaction by the actinian was seen four times in the observational period. When some tentacles touched the gastropod shell the tentacle crown was partly withdrawn, at the same time keeping contact with the shell. The column of the actinian then bent toward the gastropod. The latter did not move. A small number of tentacles only partly adhered to the gastropod shell. In two cases adhesion of the tentacles was on the side of the shell quite near the second whorl and in the other two on the anterior side so that the proboscis was touched by some tentacles, without an obvious reaction of the gastropod.

(3) Freeing the pedal disc.— The detachment of the disc followed almost without interval after tentacular adhesion. Between 10 and 20 minutes after the adherence of the tentacles to the gastropod the pedal disc appeared to be free.

(4) Arching the column.— Subsequently the column of the actinian bent sharply without detaching the tentacles (see fig. 1). Between 15 and 40 minutes elapsed before the actinian positioned its pedal disc to allow mounting of the shell. In one out of four observed cases a very small cone as depicted by e.g. Ross (1974b, fig. 3B, C, and D) in *Stomphia coccinea* (O.F. Müller, 1776) was visible in the centre of the pedal disc. Such a

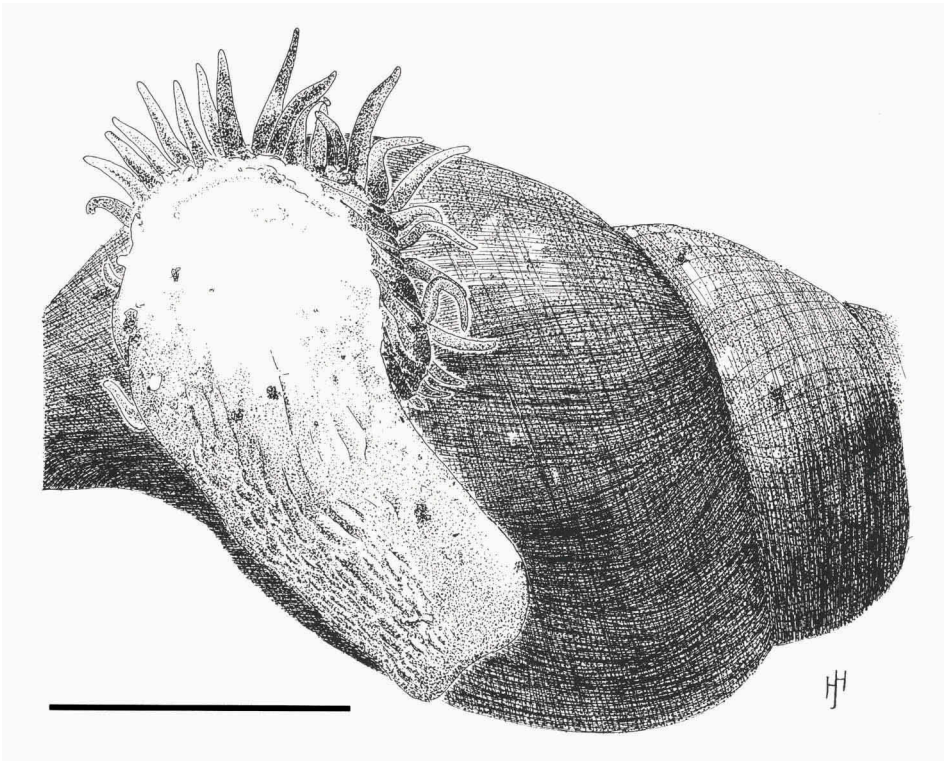

Fig. 1. The column of *Hormathia digitata* is sharply bent when mounting the gastropod (stage 4 in the mounting behaviour, see text). Scale 1 cm.

cone may have been present but obstructed from view in the other observed instances.

(5) Sticking to the shell.— The pedal disc did not flare out in the four instances witnessed. Attachment to the shell started from the edge of the pedal disc. In one case the pedal disc seemed to attach to the shell instantly, whereas in one other attachment followed in about 30 minutes. In the remaining two instances attachment to the shell took more than one hour. How long exactly is unknown as observation was stopped for reasons explained under Material and methods.

About 15 months after the first animals were put in the aquarium in all six specimens of *H. digitata* appeared to have recolonized a specimen of *C. gracilis*.

All specimens survived until July 1984 when the cooling unit broke down causing the aquarium temperature to rise to 18°C and above within 36 hours.

Discussion

"Tentacles of *H. digitata* drape themselves on the shell without strong clinging, and settling occurs by expanding the pedal disk with little flexion of the column" (Ross 1974b: 288). Although short, this description differs in most respects from my observations of the transfer behaviour in *H. digitata*. As there are no criteria for the strength of the actinian tentacle clinging to a gastropod shell I leave that aspect aside. The partial withdrawal of tentacles by *H. digitata* after getting in contact with the shell

as I saw it cannot be described as draping. I saw no expansion of the pedal disc, but I did see considerable flexion of the column of *H. digitata*.

At least three explanations for the different result are possible. Ross (1974a: 117) saw a different gastropod host, i.e. *Neptunea antiqua* (Linnaeus, 1758). My animals were certainly healthy, possibly contrary to those observed by Ross (see introduction). Lastly, different behaviour patterns may have developed in different parts of the distributional range of the species in question.

Some aspects of the transfer behaviour in *Hormathia alba* (Andres, 1881) as described by Ross & Zamponi (1982) (as *Paracalliactis mediterranea* Ross & Zamponi, 1982, see Tur, 1993) are similar to what Ross (1974b: 288) succinctly described for *H. digitata*. According to Ross & Zamponi (1982: fig. 3) *H. alba* may expand its pedal disc while hardly flexing its column when transferring to a shell. However, *H. alba* seems to withdraw its tentacles to some extent like my specimens of *H. digitata*. More experiments are desirable.

Hand (1975: 512) noted the 'overpowering' of *Austrofusus glans* (Röding, 1798) by *Calliactis conchicola* Parry, 1952. By this is meant that the actinian forces a partnership upon a passing gastropod by getting hold of it with its tentacles. I did not see anything that could be explained as such. *C. gracilis* approaches *H. digitata* and takes an attitude near it different from a resting posture. In the aquarium *C. gracilis* spends a lot of time seemingly resting, the shell pulled flush to the substratum so that no soft parts are visible (personal observation). Ross & Kikuchi (1976: 45) described a similar approaching behaviour by the gastropod *Siphonalia filosa* (Adams, 1863) in the presence of *Hormathianthus* spec. and they suggest the possibility that "the gastropod assists the actinian to settle on the shell by a form of passive co-operation". My observations indicate that *C. gracilis* is more than merely assisting its actinian. Approaching its future partner and remaining stationary near it as well as allowing it to climb on its shell, may be as important for the initiation of the symbiosis as the actual climbing by the actinian. I do not know what triggers *C. gracilis* to approach and to remain near *H. digitata*, but physical contact is not necessary for the gastropod to do it.

If attached to a gastropod, *H. digitata* is almost always located on the first whorl of its host [Stephenson, 1935: fig. 88; Dales, 1957: fig. 5 (as *Allantactis parasitica* Danielssen, 1890, see Riemann-Zürneck, 1994: 202); Pearce & Thorson, 1967: fig. 2; personal observation of specimens collected by RIVO as well as of specimens kept in the Zoological Museum, University of Amsterdam], only rarely covering part of the second whorl as well. This is even the case when two specimens of *H. digitata* are situated on one gastropod (fig. 2). I suggested (Ates, 1997: 16) that it was inconceivable how a gastropod, contrary to a hermit crab, would be capable of controlling the position of an actinian on its shell. However, the 'favourite' position of *H. digitata* on *C. gracilis* may indeed be controlled by the gastropod as a result of offering its anterior end for mounting by *C. gracilis*.

Reports on *C. gracilis* carrying *H. digitata* in nature appear to be few (Ates, 1997: 12, 13). The approaching and mounting behaviour as reported here seems to be useless if symbiotic actinians would be rare or absent in the range of *C. gracilis*. Recent North Sea records of *H. digitata* and of three species of gastropods (*C. gracilis*, *N. antiqua* and *Buccinum undatum* Linnaeus, 1758) capable of carrying it include those published by Dyer et al. (1983: 687) and Basford et al. (1989: 399). In these studies *H. digi-*

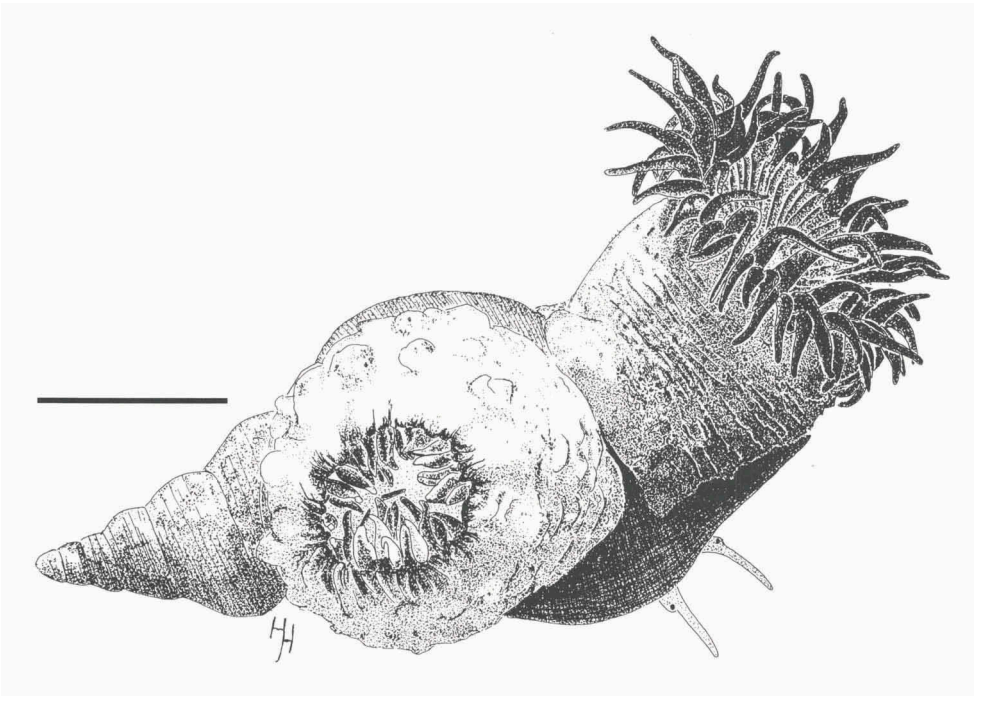

Fig. 2. Two specimens of *H. digitata* situated on the first whorl of the shell of the gastropod *Colus gracilis*. Scale 1 cm.

tata was found attached to all these three species of gastropod and to large whelk shells containing hermit crabs but more precise information is not available (pers. comm. by Dr G.J. Cranmer, Luton, England). It would be interesting to know the frequency of the (co-)occurrence of *H. digitata* and gastropods. Equally interesting would be to study the behaviour of gastropod species other than *C. gracilis* towards *H. digitata*.

Acknowledgements

Prof. C. Hand and Dr N.E. Chadwick-Furman provided comments which greatly improved the manuscript. The animals used in this study were collected by Prof. N. Daan and Mr H. Bakkernes. Mr R. Moolenbeek confirmed the identity of the gastropod. Mr H. Holsteijn (Groningen, The Netherlands) made the drawings on the basis of my pictures of dubious quality. I am indebted to all of them.

References

Ates, R.M.L., 1997. Gastropods carrying actinians.— Proc. 6th Int. Conf. Coel. Biol. 1995: 11-20.

Balss, H., 1924. Über Anpassungen und Symbiose der Paguriden, eine zusammenfassende Übersicht.— Z. Morph. Ökol. Tiere 1: 752-792.

Basford, D.J., A. Eleftheriou & D. Raffaelli, 1989. The epifauna of the northern North Sea (56°-61°N).— J. mar. biol. Ass. U.K. 69: 387-407.

Carlgren, O., 1928. Zur Symbiose zwischen Actinien und Paguriden.— Z. Morph. Ökol. Tiere 12: 165-173.

Dales, R.P. 1957. Interrelations of organisms, A. commensalism.— Mem. geol. Soc. Am. 67 (1): 391-412.

Dyer, M.F., W.G. Fry, P.D. Fry & G.J. Cranmer, 1983. Benthic regions within the North Sea.— J. mar. biol. Ass. U.K. 63: 683-693.

Hand, C., 1975. Behaviour of some New Zealand sea anemones and their molluscan and crustacean hosts.— N.Z. J. Mar. Freshw. Res. 9: 509-527.

Pearce, J.B. & G. Thorson, 1967. The feeding and reproductive biology of *Neptunea antiqua*.— Ophelia 4: 277-314.

Riemann-Zürneck, K., 1994. Taxonomy and ecological aspects of the subarctic sea anemones *Hormathia digitata, Hormathia nodosa* and *Allantactis parasitica*.— Ophelia 39: 197-224.

Ross, D.M., 1974a. Evolutionary aspects of associations between crabs and sea anemones. In: W.B. Vernberg (ed.)."Symbiosis in the sea": 111-125.

Ross, D.M., 1974b. Behavior patterns in associations and interactions with other animals. In: L. Muscatine & H.M. Lenhoff (eds). "Coelenterate Biology": 281-312.

Ross, D.M. & M.O. Zamponi, 1982. A symbiosis between *Paracalliactis mediterranea* and *Pagurus variabilis*.— Vie Milieu 32: 175-181.

Ross, D.M. & T. Kikuchi, 1976. Some symbiotic associations between anemones and gastropods in Japan.— Publs Amakusa mar. biol. Lab. 4: 41-50.

Stephenson, T.A., 1935. The British sea anemones 2.— Monogr. Ray Soc. 121: 1-426.

Tur, J.M., 1993. Redescription and biological aspects of *Hormathia alba*, a luminescent sea anemone.— Helgoländer Meeresunters. 47: 213-219.