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Parasitism in the Sipunculid, *Golfingia procerum* (Moebius)

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(With 1 Text-figure)

Summary

Golfingia procerum, hitherto regarded as a mud-inhabiting detritus-feeder, has proved to be a temporary parasite on the polychaete *Aphrodite aculeata*. The *Golfingia* introduces its long, flexible proboscis through the body wall and into the body cavity of the polychaete, which then, for some time, drags along with the parasite. This observation and notes compiled from literature seem to indicate that commensalistic and parasitic habits are more commonly met with among sipunculids than hitherto assumed.

So far very little is known about the feeding habits and food of *Sipunculoidea*. They are known to inhabit muddy and sandy bottoms, and they are supposed to feed on the detritus accumulating there and the microorganisms living in it (W. Fischer, 1925, p. 33 and 36, Wesenberg-Lund, 1937, p. 11). This latter assumption, however, is based on very few facts, field observations on these animals being scarce. Any fresh information about their ethology will, therefore, be of interest.

In the north-western part of the Kattegat, Denmark, the level muddy bottom areas from 15 to 25 m depth are inhabited by a community with the brittle-star, *Amphiura filiformis*, and the sea-urchin, *Echinocardium cordatum*, as the quantitatively dominating animals (Petersen, 1918, pp. 11–13 and plate IV). The community also comprises several polychaetes, among which the Atlantic-Pacific species *Aphrodite aculeata* L. is fairly common.

Nearly every dredge haul brought from these areas and washed through a fine-meshed sieve was, moreover, found to contain a few specimens of *Golfingia procerum* (Moebius) (= *"Phascolosoma procerum"* auct.) — a small, slender sipunculid worm known from the North-Atlantic as well as the North-Pacific Oceans (W.K. Fisher, 1952, p. 402). Observations in aquaria show that *Golfingia* buries its club-shaped body wholly or partially in the mud, while its extremely flexible proboscis ("the introvert" of Fisher 1952) is often seen moving briskly over the bottom (Fig. A a). By inversion and eversion the proboscis may vary significantly in size and shape. In an adult *Golfingia procerum* with a body length of 1 cm the proboscis may, within a few seconds, change from a 1 $^1/_2$ cm

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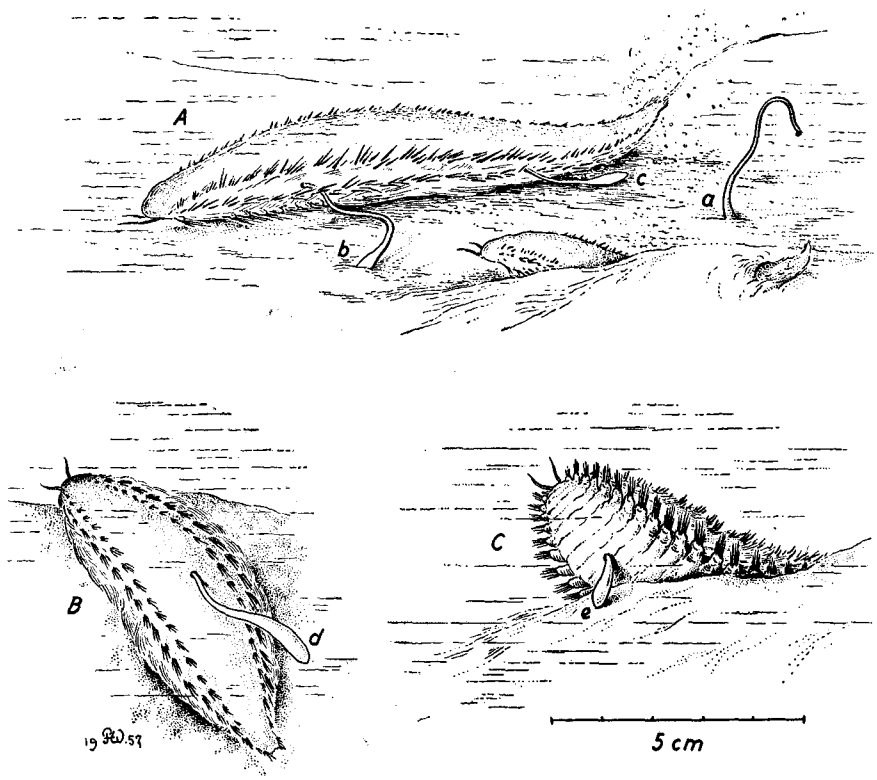
long, trunk-like appendix to a 4 to 5 cm long, slender, thread-like instrument not much thicker at its distal end than a sewing-thread.

During the summer-courses in marine biology at Frederikshavn, N.-W. Kattegat, in July 1953, a few specimens of *Aphrodite aculeata* together with some specimens of *Golfingia procerum* all of them dredged on the same day, were placed in a glass vessel and put into an ice-box (temperature 5° to 7°C) over the night. Next morning it was found that one of the *Golfingias* with its proboscis had



Different views of the parasitic sipunculid *Golfingia procerum* (Moebius) attacking the polychaete *Aphrodite aculeata* L. Sketches from life, Frederikshavn, Denmark, July 1956. Drawn by Poul H.Winther, *A a*. Parasite imbedded in the mud-bottom waiting for a host passing by. *A b*. First contact between parasite and host. *A c*. Parasite has introduced its proboscis into the body cavity of the host, which drags along with it. *B d*. Parasite attacking its host from the dorsal side through the interwoven chaetal threads. *C e*. Parasite, which has attacked the host from the ventral side and has introduced its proboscis deeply into the body cavity of *Aphrodite*.

pierced the muscular ventral surface of a 5 cm long *Aphrodite*. Only the very body, about 1 cm long, was visible outside the *Aphrodite*, and when, by force, the *Golfingia* was hauled out, it was seen that a proboscis of at least 3 to 3 1/2 cm length had been introduced into the body cavity of *Aphrodite*. The next day a *Golfingia* was observed penetrating the dorsal mat of interwoven chaetal threads of another *Aphrodite*, but in this case the proboscis was not introduced into the very body of the polychaete.

In June 1955 and July 1956 observations were continued at Frederikshavn on a somewhat larger scale, and it soon became evident that the introduction of the *Golfingia* proboscis into the body cavity of the *Aphrodite* took place regularly when these two species were in contact with each other. The present author has had the opportunity to watch the very process of introduction of the proboscis, as well as specimens of *Golfingia* which had already introduced their proboscis into an *Aphrodite*, in all together about 30 to 35 times. Some chemical sense seems to be involved, for the most freshly looking individuals of *Golfingia* responded very quickly when an *Aphrodite* touched them or passed them at a distance of 1 cm or less. The proboscis attaining its slender, thread-like shape, was moved over the surface of the *Aphrodite* and soon, by a slight invagination of its distal parts, fixed itself by sucking to a bristle or to the very surface of the polychaete (fig. A b). In a few minutes the *Golfingia* would pierce the body wall and insert its proboscis while dragged along by the *Aphrodite* (fig. A c), which, continuing its locomotion at the same speed as before (i.e. about 110 mm per minute), did not show any visible reaction to the attack. In one case an *Aphrodite* without parasite was placed among the *Golfingias*. When examined ten minutes later, one *Golfingia* had already established itself so comfortably that only its very 1 1/2 cm long body was visible outside its host (like the situation sketched in fig. C e).

The *Golfingia* does not seem to suck on its host for any very long time. Parasites with their proboscis deeply introduced into an *Aphrodite* were often, when examined half an hour later, found to move freely on the bottom. The parasites also seem to be very sensitive to changes in light intensity, water-temperature, or other external stimuli, and if disturbed, they quickly retire from their victim. This observation seems to explain why specimens of *Aphrodite* caught in a dredge haul have never been found with *Golfingia* sucking on them. Thus, *Golfingia* is a temporary parasite only.

The parasite may easily penetrate the surface of an *Aphrodite* in any place and has been observed to do so. Statistically, however, there seems to be a preference among the golfingias to introduce their proboscis through the lateral parts of *Aphrodite*, among the golden bristles. The reason of this may be that these parts of the polychaetes are most easily accessible to the parasites, which, sitting in the mud, are on a "look out" for a host passing by. It may, however, also be related to the fact that the lateral body walls of *Aphrodite* are more easy to penetrate than the muscular ventral surface and the dorsal surface hidden

below the elytras (See : Fordham, 1926, pl. V, fig. 38). It also seems reasonable to assume that the external openings of the nephridia, connecting the body-cavity of *Aphrodite* with the exterior, might stimulate the chemical sense of *Golfingia* more than other parts of the polychaete's body. Since the nephridia open ventrally, i.e. below the parapodia, while *Golfingia* in most cases introduces its proboscis laterally, i.e. above the parapodia, no evidence supporting this view was, however, found.

When fully everted, the proboscis of *Golfingia* wears on its very tip a crown of tentacles which seems to make it less suitable as a penetrating instrument. A proboscis in the act of being introduced into *Aphrodite* is, however never fully everted. With the tentacle crown still somewhat invaginated, the distal part of the proboscis may attain that flexible, thread-like, pointed shape which allows it to pierce the polychaete's body without difficulty.

A few experiments were carried out in which fresh specimens of *Golfingia* were brought into contact with other species of polychaetes. So far, however, no response was seen, but the observations are too few to allow us to draw any conclusions. — *Aphrodite*, on the other hand, which is very voracious and is known to feed on worms much larger than *Golfingia*, in the experiments made so far was never seen to attack its parasite.

Golfingia procerum, hitherto regarded as a harmless detritus-feeder, has thus proved to be a temporary parasite, which, partially buried in the mud, moves its flexible proboscis over the bottom waiting for a victim to turn up. With this fact in mind it seems reasonable to reexamine the feeding habits of other species of *Golfingia* and even of related genera to see whether any suggestions of commensalism or parasitism should be found.

As to Californian sipunculids W. K. Fisher (1952) gives some notes which, when compared with our fresh knowlegde about *Golfingia procerum*, seem to support the conjecture that commensalistic and parasitic habits are more common within this group than hitherto believed. According to Fisher's paper (1. c., p. 375), 19 specimens of *Golfingia margaritacea californica* observed at San Lucas Cove, Baja California, were "commensal in tubes of *Cerianthus*". In the genus *Dendrostomum*, a specimen of *D. hexadactylum* at Monterey Bay, Calif. "evidently lived in a cavity excavated by boring mollusks in gray shale" (Fisher, p. 411), while *D. dyscritum* at Dillon Beach, Calif., was found "in fissure of rocks with *Pholadidea* and *Petricola carditoides*" (Fisher, p. 419). In the genus *Phascolosoma*, Fisher (p. 434) records 10 specimens of *P. dentigerum* from El Pulmo Reef, Baja Calif. as taken "in interstices of living coral, *Pocillopora*". — Most interesting, however, is an observation on *Phascolosoma agassizii* from Orcas Island, Washington. The observer, Dr. Richard Snyder here "found a medium-sized specimen in association with the annelid *Aphrodite*. The sipunculid was in the space between the elytra and the dorsal mat of interwoven chaetal threads and must have entered when very tiny". (Fisher, 1. c., p. 426).

The latter observation is in such good agreement with the facts found for *Golfingia procerum* that it seems natural to assume that *Phascolosoma agassizii* is also a parasite on *Aphrodite.*

Observations by Edmonds (1956) seem further to support the assumption of commensalistic-parasitic habits in sipunculids. So, *Phascolosoma tasmaniense* in the Kangaroo Island, S. Australia, was found "embedded in thick mass of tubes of the serpulid worm, *Galeolaria*" (l.c., p. 285), *Phascolosoma dunwichi* at Queensland "in mussel clumps", "under oyster shells", "in mussle formations", and "amongst *Pyura*" (l.c., p. 292), and *Dendrostomum signifer* at Queensland "between rocks and mussel clumps", and "in crevices either between mussels or oyster shells or beneath oyster shells" (l.c., p. 297).

So, new observations on an experimental basis on the feeding habits of the sipunculids are highly needed.

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