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Transoceanic dispersal of benthic macrofauna: *Haliplanella luciae* (Verrill, 1898) (Anthozoa, Actiniaria) found on a ship's hull in a shipyard dock in Hamburg Harbour, Germany

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ABSTRACT: In September 1993, 26 live specimens of the small, delicate sea anemone *Haliplanella luciae* (Verrill, 1898) were sampled from the hull of a ship docked in Hamburg Harbour. After a worldwide journey the ship had passed into the freshwater region of the river Elbe. Although the migratory potential of the species (supposed home region is Japan) is well known, its transport on ships' bottoms has never been documented. Behavioural traits enabling the anemone to settle on ships are discussed together with probable reasons why *Haliplanella luciae* did not establish itself in the fauna of the German Bight.

INTRODUCTION

With the increasing reports of local and global change in the marine environment the number of recognized and cryptic invasions of foreign marine species into coastal communities is also increasing, whereby ballast water is usually considered the means of long-distance transport (Carlton & Geller, 1993). By contrast, the transoceanic transport of benthic macrofauna on ships' hulls is rarely considered.

Haliplanella luciae, known as the "orange-striped" or "striped" sea anemone (Fig. 1), has long been known as a striking example of a migratory and colonizing species, which established itself successively at various points on the coasts of North America and Europe with its supposed home region being the western Pacific (Stephenson, 1935).

Besides the early supposition that *H. luciae* might have been transported to its new localities together with imported mussels and oysters (Verrill, 1898), it was also assumed that the anemones travelled on ships' bottoms, particularly as most of the new sites were close to international shipping routes and/or harbours (Stephenson, 1935). However, the

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observation of *H. luciae* specimens attaching themselves to ships has never been documented.

MATERIAL

During a research project financially supported by the German Umweltbundesamt (Berlin) on the potential ecological significance of foreign organisms imported by ships, a routine sampling program was carried out in Hamburg Harbour. Specimens of the sea anemone *Haliplanella luciae* were sampled from the hull of the ship "Nosac Sun", a car-carrier (port of registry: Oslo), on September 16, 1993 after the ship had been docked. The ship's route before docking was Hamburg (early July); the Mediterranean and Red Sea (late July); Japan (Yokohama and Kobe; early August); Pacific coast of USA (Los Angeles; late August); Panama Canal (late August); Atlantic coast of USA (Jacksonville, Baltimore, and New York; early September); and Hamburg (September 15, 1993).

The *Haliplanella* specimens sampled from the ship's bottom were exposed to several environmental hazards during the last 24 hours. Early in the morning of September 15th, the "Nosac Sun" approached the Elbe estuary, passing the light-ship "Elbe 1" at 07.30 h, reaching the harbour and docking site at 14.00 h. During these 6.5 hours the actinians on the ship's bottom had to experience a salinity reduction from 32 ‰ to 0.5 ‰. Two and one half hours later (16.30 h) the ship was docked, and the fouling community was exposed to 14.1 °C air temperature and gentle rain. There was no rain during the night, but rain began to fall the next morning at 08.30 h with an air temperature of 11.2 °C that decreased to 9.5 °C later that morning. The organisms were sampled at 11.30 h and transported to the laboratory, where they were transferred to seawater of 33 ‰ at about 13.00 h. Thus, the sea anemones experienced freshwater conditions for about 8 hours and air exposure and rain for about 20 hours.

The fouling community covered about 25 % of the ship's hull. *H. luciae* was found in only one sample (out of six) that consisted of 14 live oysters (*Crassostrea gigas*, about 3 to 7 cm in size), with *H. luciae* settled on 6 of the oysters. The sample also contained serpulids and balanids. The sea anemones were discovered only after the sample had been transferred to seawater, and subsamples were then maintained at different temperatures between 5 and 20 °C. Seven specimens were subsequently preserved together with the oyster on which they settled.

Material of *Diadumene cincta* Stephenson (1925) originating from collections of Prof. H. Caspers from 1968 through 1972 ("Tiefe Rinne" near Helgoland) was investigated for comparison. In addition, there are a number of somewhat aberrant specimens of *Diadumene cincta* which were collected by S. Kühne during his dives in 1991 ("Steingrund" near Helgoland; erroneously given as *"Haliplanella lineata"* in Kühne, 1992 and Harms, 1993). In freshly preserved condition these specimens exhibited alternating fawn brown and cream stripes with conspicuous dark cinclides that look rather reminiscent of plants' stomata.

TAXONOMICAL REMARKS

In recent publications (Manuel, 1981; Ramil Blanco, 1987; Shick, 1991) *Haliplanella luciae* (Verrill, 1898) has been synonymized with *Haliplanella lineata* (Verrill, 1869), the

latter name having priority. We do not concur with this opinion, because the synonymy is based solely on the suspicion that a species described by Verrill in 1869 from Hong Kong might be identical with *H. luciae*, and this supposition has never been substantiated (see Williams, 1978). In agreement with den Hartog (1978), we think that the separate family status of the species (Haliplanellidae Hand, 1956) should be abandoned, as there is no reason left to separate *H. luciae* from the Diadumenidae. Whether or not the genus *Haliplanella* is justified is still open to discussion.

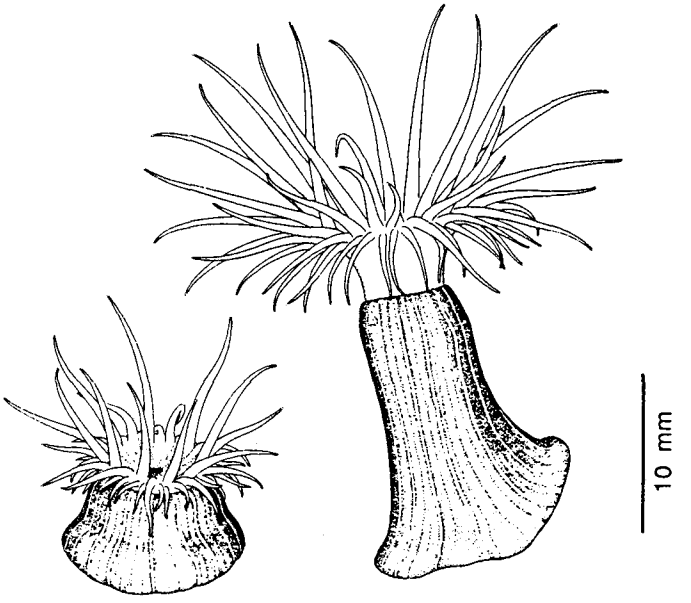

Fig. 1. *Haliplanella luciae* (Verrill, 1898) (after Manuel, 1981, text fig. 47: "Partly and fully expanded examples")

RESULTS AND DISCUSSION

The *Haliplanella luciae* specimens from the "Nosac Sun" which had suffered freshwater and air exposure for more than 24 hours were fully expanded in the aquaria the morning after sampling and were viable at all offered temperatures (5 to 20 °C). They were small (about 10 millimeters high in expanded condition) and exhibited the typical colour pattern of the species, although slightly duller than usually reported: dark gray column with a number of pale longitudinal stripes; the expanded tentacular crown (capitulum, oral disc and tentacles) was gray translucent.

The seven specimens preserved with the live oyster on which they settled were 1 to 5 millimeters in diameter. They were not fully contracted, with a mucus coating around

the lower part of the column. The cnidome of the specimens agrees with what is known of the species (Carlgren, 1945; Hand, 1956; Widersten, 1976), except that the smaller p-mastigophores noted by Hand in the acontia were not present. Although it may be supposed that the individuals all originated from one founder animal, there are size discrepancies of about 10 µm in the large p-mastigophores of the acontia in different specimens (38–45 × 6 µm, respectively 43–55 × 6–6.5 µm).

H. luciae is capable of long-distance passive dispersal, with the adult albeit asexual anemone being the migrating stage. Prerequisites which make this intertidal sea anemone such a successful migrant are its extreme tolerance towards abiotic factors and its rapid asexual proliferation. The conditions to which the Haliplanellas from the "Nosac Sun" were submitted during their voyage and in particular during the last 24 hours on the ship's hull read like a summary of what scientists learned of the species in the past 100 years (see Stephenson, 1935; Shick, 1991 and references therein).

In addition to these ecological and physiological peculiarities, there are some rarely considered specific behavioural traits, which we think essential in achieving transport via ships.

In 1903, Davenport stated that "when the water becomes foul or from other causes it may voluntarily detach itself and roll about the aquarium or hang upside down from the surface film" (see also Walton, 1908; Pax, 1920). In a tiny anemone like *H. luciae* it may be suggested that detached specimens float for some time in turbulent waters. This together with its preference for vertical and overhanging surfaces (Hausman, 1919) may explain why ship hulls are attractive and within reach of the species.

Also, *H. luciae* seems to be associated almost exclusively with mussels or oysters. In recruitment experiments done in California, Graham & Gay (1945) found the species only on one single panel that had been exposed for 6 months. This led them to believe that "apparently these anemones attach themselves only to surfaces already heavily fouled by other organisms".

This assumption is supported by our finding that *H. luciae* is found on oysters only, which were the first to colonize the ship. These resistant, fouling organisms may also offer some shelter for the delicate anemones on a ship's hull that is usually exposed to heavy physical stress by the sea.

As shown in laboratory culture and in the field, *H. luciae* has the potential for rapid asexual reproduction both by fission and pedal laceration (see Shick, 1991 and literature therein). This potential may also play a part as a means of dispersal in that a founder animal on a ship's bottom may already proliferate during the voyage and thus may be spread to more than one new locality. The fact that only one sample of the fouling community yielded 26 specimens again confirms this assumption: as most probably, these 26 Haliplanellas are clone mates produced by one founder animal. Where the "Nosac Sun" picked up the founder anemone is impossible to say, as *H. luciae* inhabits all three coasts at which the ship called (Japan, Pacific and Atlantic coast of USA).

It is surprising that a species with the above stated potentials did not establish itself in the fauna of the German Bight. Contrary to both old and recent records from Holland and from British coasts (Stephenson, 1935; Hamond & Williams, 1977; Williams, pers. comm.; Braber & Borghouts, 1977; Dekker, 1982; Faase, 1992), *Haliplanella luciae* has been documented only once in Germany, in the intertidal zone of Büsum, north of the Elbe estuary, where a population dwelt between 1920 and 1924 (Pax, 1920, 1921;

Stephenson, 1935). This historical Büsum locality is easy to explain after assuming that a *Haliplanella* specimen dropped off a ship's bottom at the entrance to the estuary of the river Elbe and was then transported by the regular coastal current to Büsum.

H. luciae was never discovered in the German Bight again, not even in recent times, even though car-carriers provide a regular and frequent connection between Japan, USA and Europe, with Bremerhaven, Emden, and Hamburg being the ports at which the ships call in Germany. The main reason why *H. luciae* did not establish itself in the fauna of the German Bight is certainly the fact that these international ports are respectively low salinity and freshwater ports, and salinities below 12 ‰ are ultimately lethal for the species (Shick, 1991).

Another possible reason for the poor settling success of *H. luciae* in the German Bight might be another sea anemone, *Diadumene cincta* Stephenson (1925), a species which is similar both taxonomically and ecologically but exhibits effective aggressive behaviour towards other sea anemone species (Williams, 1975). *D. cincta* is believed to have been imported to European coasts in the 'twenties of this century (Pax, 1936) and is now a common species down to about 15 m depth around Helgoland (Harms, 1993), where it occupies habitats (piers, pilings and other hard substrate) that may also be potential substrates for *Haliplanella luciae*. Thus, under the presently prevailing conditions and considering the limitations of an asexually reproducing species, *H. luciae* seems to be unable to compete successfully. Nevertheless, as Williams (1973) pointed out, populations of *H. luciae* may be quite different in their physiological (and genetical) makeup, and with the assumed continuous transport of ships and the increasing environmental changes, the situtation may well change in the future.

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