

On the Burrows of *Lepidophthalmus louisianensis* (SCHMITT 1935) (Decapoda: Thalassinidea: Callianassidae)

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With 3 Text-Figures

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Abstract

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Two resin casts of the burrows of the thalassinidean decapod *Lepidophthalmus louisianensis* were made *in situ* on a tidal flat at Dauphin Island, Alabama. The following burrow sections can be recognised: an upper narrow shaft leading from the surface to a depth between 17 and 28 cm; a main wider shaft with several chambers leading to a depth of more than 1 m; short horizontal tunnels branching off the main shafts at several depths. The burrow wall has a thick lining in all parts except on bottoms of the horizontal tunnels and has a higher organic content than the ambient sediment.

Introduction

Callianassid shrimps are burrowing crustaceans mainly found in various sediments of intertidal and shallow subtidal zones (DWORSCHAK 1987), but are also common in deeper subtidal waters (WITBAARD & DUINEVELD 1989; ROWDEN & JONES, 1994). Most members of the Callianassidae live in marine and brackish environments. Members of the genus *Lepidophthalmus*, however, are known especially from low salinity habitats (MANNING & FELDER 1991). The burrowing ghost shrimps have received increased attention recently, as some species occur in large numbers in penaeid shrimp ponds, where they have a negative impact on the cultured shrimps due to their bioturbation activity (NATES & FELDER 1998).

In the Gulf of Mexico, *Lepidophthalmus louisianensis* is the most common callianassid shrimp along muddy shorelines of low salinities (WILLIS 1942; PHILLIPS 1971; FELDER & GRIFFIS 1994). Several aspects of its biology were studied in detail, including their respiratory and osmoregulatory capacities (FELDER 1978, 1979), relative growth (FELDER & LOVETT 1989), larval development (NATES et al. 1997), population dynamics (FELDER & GRIFFIS 1994) and bioturbation activity (NATES & FELDER 1998). Information on their burrow shape, however, is still scarce.

This study presents a description of the burrow morphology of *L. louisianensis* based on two resin casts made at a tidal flat at Dauphin Island, Alabama.

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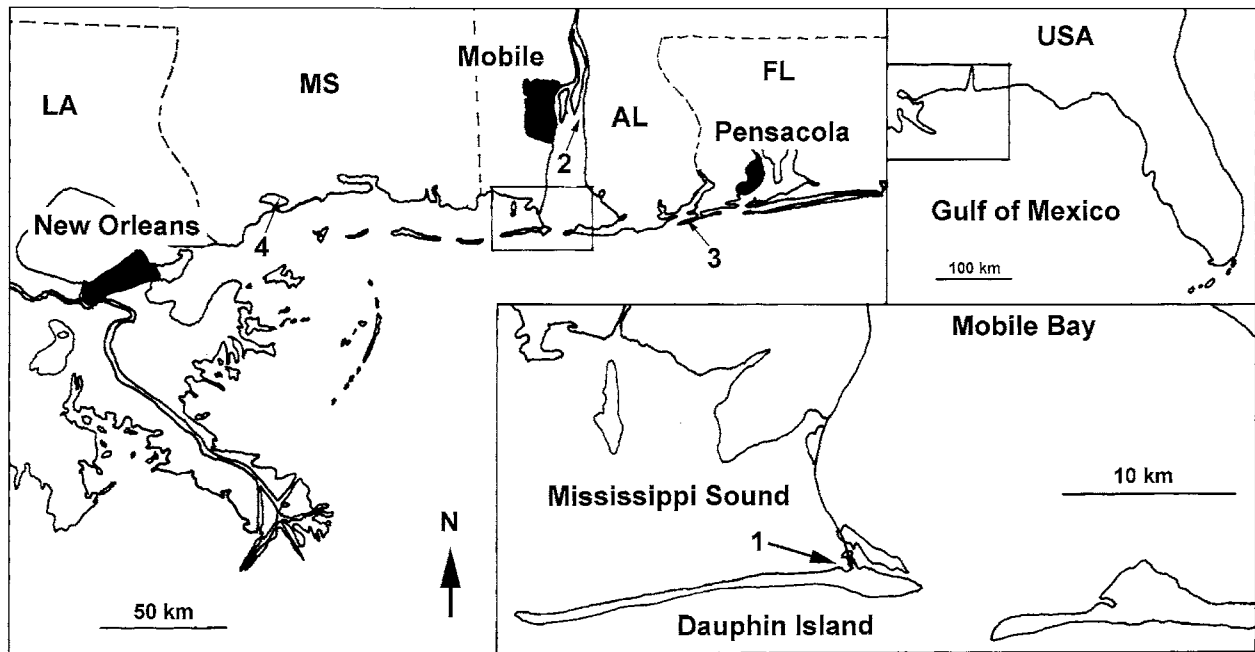


Fig. 1. Sampling locations in the Gulf of Mexico.

Environmental Setting

The study was carried out in the Gulf of Mexico in the Mississippi Sound of Dauphin Island, Alabama, in September 1990 (Fig. 1). A small tidal flat (10 m wide at low water) is situated at the eastern end of the airport's runway at the entrance of a creek leading into a marsh (30°15'37"N, 88°07'39"W). Tides are diurnal with a mean range of 0.37 cm (Dauphin Island Sea Lab 1989). The sediment is a medium sand with a median diameter of 378 μm , a fine fraction (<63 μm) of 2.7%, and an organic content ranging from 0.2 to 0.7% (weight loss

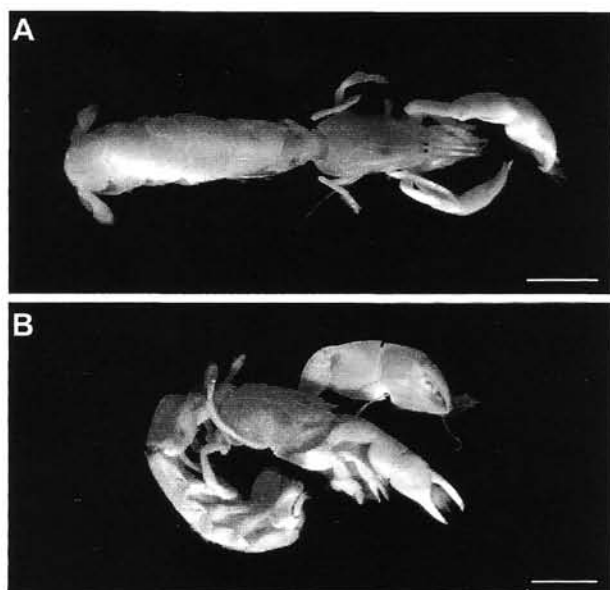
on ignition at 450°C). Salinity ranges between 4 and 26 with lowest values between 4 and 5 in February and March; water temperature ranges between 11°C in December and 34°C in summer (HSUEH et al. 1993). Additional sampling was done in Mobile Bay, at the northern end near Meaher Park (mud flat with *Elodea* and freshwater marsh). Here, salinity reaches low values between 1 and 3. Additional observations and animal samples were taken in Bay Saint Louis, Mississippi (see FELDER & GRIFFIS 1994), and in Big Lagoon, Perdido Key, Florida.

Material and Methods

Lepidophthalmus louisianensis (Fig. 2) was described for the first time as a variety of *Callinassa jamaicensis* by SCHMITT (1935). RODRIGUES (1971) and TIEFENBACHER (1976) could not recognise a difference between the two forms. It has been treated as a distinct species first by WILLIAMS et al. (1989) and FELDER & LOVETT (1989). Recently, MANNING & FELDER (1991) revived the genus *Lepidophthalmus* HOLMES and placed the American species *C. jamaicensis* and *C. louisianensis* into this genus. The latter species is endemic to the northern and western coastlines of the Gulf of Mexico from western Florida through Alabama, Mississippi, Louisiana, Texas to the northern state of Veracruz, Mexico (FELDER & RODRIGUES 1993). FELDER et al. (1991), however, mention that in the southwestern Gulf of Mexico, *L. louisianensis* is replaced by an as yet undescribed species.

Resin casting was done at the Dauphin Island airport mud flat as outlined by PERVESLER & DWORSCHAK (1985). First attempts at casting yielded only short stumps as the burrow below did not fill with resin. In subsequent attempts the upper sediment layer was removed carefully during low tide to the depth where the burrow widens. A tube with a funnel was inserted into the burrow and the resin poured into the funnel. This resulted in two nearly complete casts of the burrows.

Sediment taken with a acrylic glass core (inner diameter 5 cm) was analysed for grain size according to BUCHANAN (1984). Density of burrows was estimated by counting holes in 1/16 m² frames. Burrowing shrimps were captured either with a „yabby pump“ similar to that described by MANNING (1975) or with a water jet as described by BYBEE (1969). For reference, preserved specimens were deposited in the Naturhistorisches



Museum in Wien (NHMW). Size of the animals is given as carapace length (CL) and palm length of the major cheliped (PLma).

In the laboratory, the behaviour of the shrimps was observed in small aquaria filled with natural sediment.

Fig. 2. *Lepidophthalmus louisianensis*, Bay Saint Louis, MS, NHMW 6979. – A: Male in dorsal view. – B: Male in side view. – Scale is 1 cm.

Results

At the sediment surface, openings of *Lepidophthalmus louisianensis* are characterised by small circular holes (diameter 3–6 mm). Sometimes these holes are surrounded by a brown halo (diameter 3–5 cm) (Fig. 3A) or appear as a chimney (diameter 1.5–3 cm) due to erosion (Fig. 3B). Hole density ranged from 4 to 112 m⁻² at Dauphin Island. In Bay Saint Louis, burrow openings occurred in densities of 76 to 77 m⁻² (Fig. 3B).

From the sediment surface, a narrow (3 to 6 mm in diameter) shaft leads to a sediment depth of 17 to 28 cm, where the burrow widens to a diameter of 11 to 16 mm.

The first cast (Fig. 3C, D) consists of a series of chambers (19 to 25 mm in diameter) connected by segments with circular cross-section, a regular diameter (10 to 12 mm) and dip angles between 60 and 80°. From two chambers, in a sediment depth of 47 and 62 cm, respectively, short (up to 20 cm) horizontal tunnels with short (2 to 13 cm) side branches branch off. This cast reached a depth of over 107 cm; the deepest part could not be recovered due to the shifting sand. An animal (CL = 14 mm, PLma = 8 mm) was entombed in one of the horizontal tunnels (see arrow in Figs 3C, D).

The second cast (Fig. 3E) is of similar shape, with chambers (diameter 25 to 29 cm) in 45, 67, 74, and 107 cm sediment depth connected by segments with diameters ranging between 15.5 and 18.3 mm, and a dip angle of 60° in the upper and 75° in the lower part. At a sediment depth of 87 cm, a longer (33 cm) tunnel (dip angle 20°) branches off. This tunnel has 3 further short (6 to 15 cm) blindly ending side

branches. This burrow was recovered to a total depth of 110 cm where it broke off due to the entombed animal (PLma = 12 mm).

The burrow with its series of shafts and chambers follows the general shape of a spiral (Fig. 3D).

In both casts, several short (3–5 cm) shafts with irregular diameter (5 mm in diameter) and rough exterior surface branch off the tunnels (positions indicated by question marks in Fig. 3C, E).

The burrow wall, as judged from the resin casts, is smooth in the vertical parts and the roofs of horizontal parts. The upper, narrow burrow section is surrounded by agglutinated sediment which can be removed from the sediment in the form of a tube with an inner diameter of 3–5 mm and an outer diameter of 1.5–3 cm. The organic content of the agglutinated sediment is higher (1.4%) than that of the ambient sediment (0.2–0.7%). The lower burrow parts also have a thick (5 mm) lining of fine sediment which adheres to the resin. Bottoms of chambers and the horizontal burrow parts lack such a lining. This is indicated especially in the horizontal parts, where the resin penetrated into the interstices of the sand (Fig. 3F).

In the laboratory, *L. louisianensis* was a rapid burrower; it entered the sediment to its whole length within one minute and had constructed a simple burrow after a few hours. After one day, the bottom of the sediment in the aquarium (30 cm) was reached; the burrow wall showed a lining with mud.

Discussion

Burrows of *Lepidophthalmus louisianensis* as investigated by resin casting have been described briefly by FELDER & GRIFFIS (1994) as consisting of a narrow upper shaft, 5–15 cm long, and a single shaft with short, blindly ending tunnels. They

report only one opening per burrow, which reach a depth between 40 and 200 cm. FELDER & STATON (1990) found burrows reaching a depth of 2.5 m and mention intersections between individual burrows in Bay St. Louis, MS, while NATES

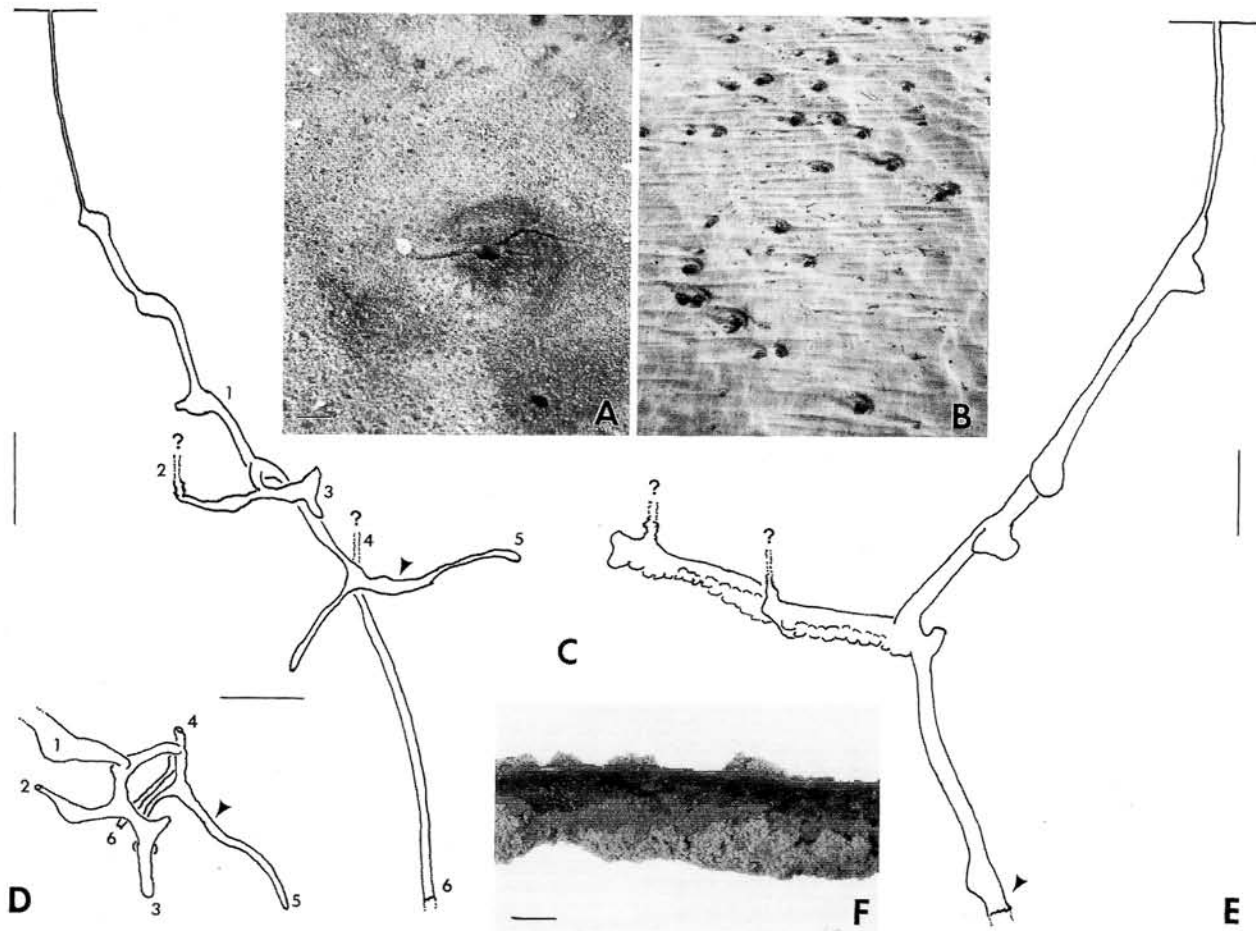


Fig. 3. Burrow openings and burrows of *Lepidophthalmus louisianensis*. —A: Two burrow openings in the intertidal at Dauphin Island, Alabama; note dark halos. —B: Burrow openings in the intertidal in Bay St. Louis, Mississippi, note eroded chimneys, distance across foreground is 80 cm. —C: Cast 9009/1 in side view. —D: same cast viewed from above, numbers indicate same position in C. —E: Cast 9009/2 in side view. —F: Detail of E showing tunnel with rough floors. Arrows indicate position where animal was entombed; question marks indicate probable abandoned shafts to surface. —Scale is 1 cm in A and F, 10 cm in C, D, and E.

& FELDER (1998) give burrow depths of only 90 cm. PHILLIPS (1971) measured burrow depths of 32–137 cm by inserting flexible plastic tubing. Burrows of other *Lepidophthalmus* species have also been described only very briefly. *Lepidophthalmus sinuensis* from Caribbean Columbia, for example, is Y-shaped with two burrow openings (LEMAITRE & RODRIGUES 1991). FELDER & GRIFFIS (1994) described burrows of this species to have 3 openings, more branches (than *L. louisianensis*) and to reach a depth of 30–50 cm. NATES & FELDER (1998), however, figured a maximum depth of ca. 80 cm. Burrows of the Pacific *L. bocourti* are described as being similar to those of the other species; a maximum burrow depth of 60 cm is figured by NATES & FELDER (1998).

The burrow wall of *L. louisianensis* was described by PHILLIPS (1971) as consisting of cohesive clay-like mud with a smooth mucilaginous lining. GRIFFIS & FELDER (1993) report that *L. louisianensis* concentrate organic matter and fine particles in a thick burrow wall lining. According to FELDER & GRIFFIS (1994) the burrow wall consists of a thin inner lining and a thicker outer matrix. They found a higher organic con-

tent (3.6%) in the wall sediment compared to ambient sediment (0.5%). The burrows presented in this study showed this lining only in the vertical parts and the roofs of tunnels, whereas tunnel bottoms were not lined. A lining of the wall with mucus only on roofs of tunnels has also been observed in other callianassids, e.g. in *Callianassa tyrrhena* and *C. candida* (DWORSCHAK, 1998).

The burrow of *L. louisianensis* resembles in its general shape that of *Callinectes major* (RODRIGUES 1983; SUGUIO et al. 1984) in having a long narrow vertical upper part leading down from the surface to a depth of 14 cm, where the diameter becomes larger; this is followed by a predominantly vertical shaft with horizontal ramified side branches in a depth of 50 cm. In *C. major*, however, there are no chambers along the vertical shaft and the horizontal side branches are not lined both on the roofs and on the floors (RODRIGUES 1983; pers. obs. 1994). Both the burrows of *L. louisianensis* and those of *C. major* can be classified as Type 4 according to the model proposed by GRIFFIS & SUCHANEK (1991); the deep reticulate pattern is indicative for filter/suspension feeding. Using the alternative

approach proposed by NICKELL & ATKINSON (1995), features such as 'narrow exhalant shaft' and 'circular tunnel cross section' found in *L. louisianensis* burrows are indicative for suspension feeders. Suspension feeding with the antennae has been observed in aquaria for *C. major* (RODRIGUES 1966;

RODRIGUES & HÖDL 1991). For *L. louisianensis*, NATES & FELDER (1998) assumed that the animals derive nutrition from a combination of deposit feeding, plankton filtration and grazing on microbially enriched, encrusted burrow walls.

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