



## **Lebensspuren of Station M**

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### LEBENSSPUREN CATALOGUE

‘Lebensspuren’ are traces left by animals on the seabed. Lebensspuren visible in Rover (Pulse 58 and 59) and Tripod (Pulses 58-60) photos captured at Station M in the NE Pacific (at approximately 4000 m depth, 34°50’N, 123°06’W) were classified into 22 morphotypes, grouped by presumed primary function: locomotory tracks (10 morphotypes), burrows and holes (4 morphotypes), feeding impressions (1 morphotype), fecal matter (5 morphotypes), and unknown traces (2 morphotypes). A catalogue of lebensspuren was created (Appendix 1), including morphology, approximate size and associated trace creators. Morphotypes were named and categorized to match existing names given to similar/identical morphotypes in other locations across the globe (Bell *et al.*, 2012, Bett *et al.*, 1995, Dundas, 2009, Ewing and Davis, 1967, Heezen and Hollister, 1971, Hollister *et al.*, 1975, Kitchell *et al.*, 1978, Ohta, 1984, Przeslawski *et al.*, 2012, Young *et al.*, 1985), without conflicting with existing names in VARS. It is understood that several lebensspuren types may result from activities with multiple functions, for example locomotory traces produced by deposit feeders that feed in transit. These lebensspuren categories and morphotypes were added to MBARI’s Video Annotation and Reference System (VARS)(Schlining and Stout, 2006) to facilitate consistent, traceable image annotation.

## References:

Bell, J. B., D. O. B. Jones and C. H. S. Alt (2012). Lebensspuren of the Bathyal Mid-Atlantic Ridge. *Deep-Sea Research Part II: Topical Studies in Oceanography*, **98**(B):341-351.

Bett, B. J., A. L. Rice and M. H. Thurston (1995). A Quantitative Photographic Survey of Spoke-Burrow Type Lebensspuren on the Cape-Verde Abyssal-Plain. *Internationale Revue Der Gesamten Hydrobiologie*, **80** (2):153-170.

Durden, J. M. (*in prep.*). Lebensspuren of the Porcupine Abyssal Plain. *In*: PhD thesis.

Heezen, B. C. and C. D. Hollister (1971). *The Face of the Deep*. New York: Oxford University Press.

Kaufmann, R. S. and K. L. Smith (1997). Activity patterns of mobile epibenthic megafauna at an abyssal site in the eastern North Pacific results from a 17-month time-lapse photographic study. *Deep-Sea Research I*, **44** 559-579.

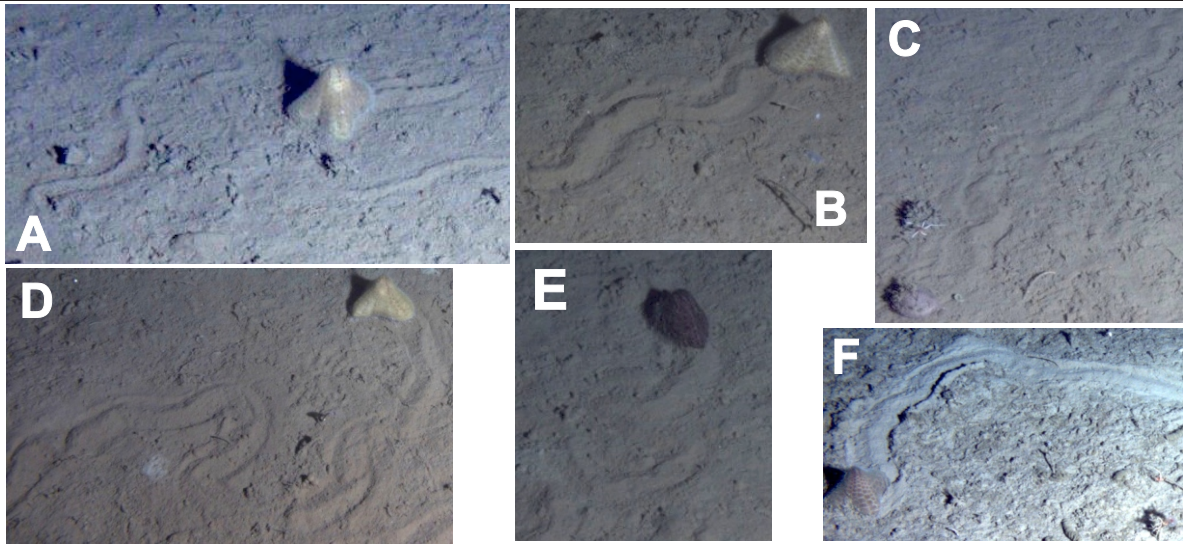
Kitchell, J. A., J. F. Kitchell, G. L. Johnson and K. L. Hunkins (1978). Abyssal Traces and Megafauna - Comparison of Productivity, Diversity and Density in Arctic and Antarctic. *Paleobiology*, **4** (2):171-180.

Ohta, S. (1984). Star-Shaped Feeding Traces Produced by Echiuran Worms on the Deep-Sea Floor of the Bay of Bengal. *Deep-Sea Research Part a-Oceanographic Research Papers*, **31** (12):1415-1432.

Przeslawski, R., K. Dundas, L. Radke and T. J. Anderson (2012). Deep-sea Lebensspuren of the Australian continental margins. *Deep-Sea Research Part I: Oceanographic Research Papers*, **65** (0):26-35.

Smith Jr, K. L., N. D. Holland and H. A. Ruhl (2005). Enteropneust production of spiral fecal trails on the deep-sea floor observed with time-lapse photography. *Deep Sea Research Part I: Oceanographic Research Papers*, **52** (7):1228-1240.

Young, D. K., W. H. Jahn, M. D. Richardson and A. W. Lohanick (1985). Photographs of Deep-Sea Lebensspuren - a Comparison of Sedimentary Provinces in the Venezuela Basin, Caribbean Sea. *Marine Geology*, **68** (1-4):269-301.



**W-shaped track**

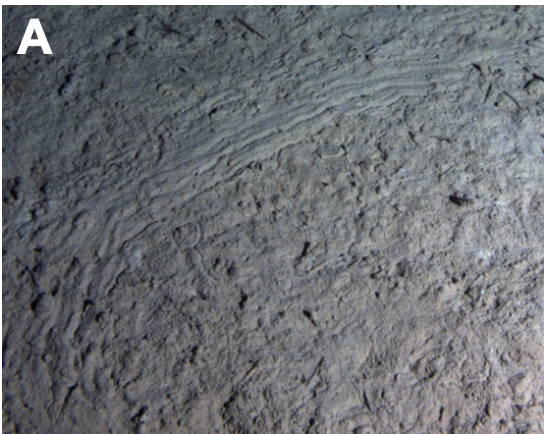
Group: Locomotory traces (tracks)

Description: 'W'-shaped plowed track with raised centreline Width: ~5 cm

Trace maker: *Echinocrepis* sp., *Cystechinus* sp., *Cystocrepis* sp.

Reference: Heezen and Hollister 1971; 'Group IIIA14/B14' Ewing and Davis 1967;

Kaufmann *et al.* 1989 Rover images: A,B,C,D,E,F Tripod images: not shown



**Wide shallow grooved track**

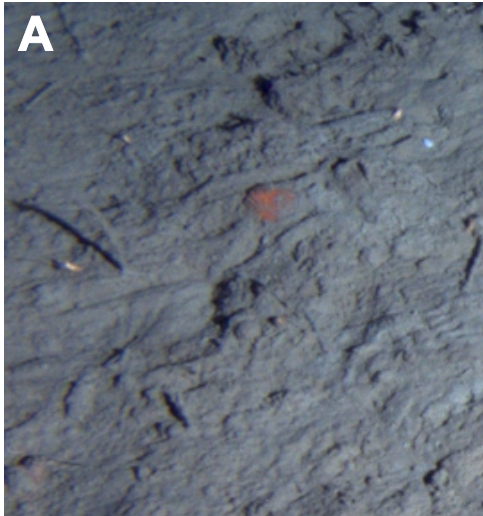
Group: Locomotory traces (tracks)

Description: Wide, shallow depressed track with small grooves along it

Width: ~3 cm

Trace maker: ?Holothurian Reference: Durden (*in prep.*)

Rover images: A Tripod images: none



### Repeating v-shaped track

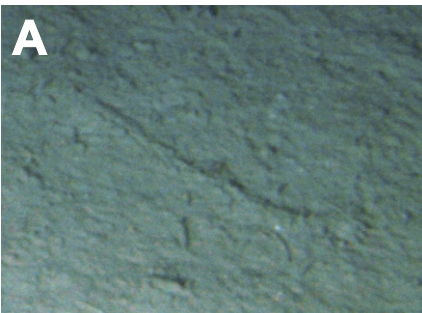
Group: Locomotory traces (tracks)

Description: Track of repeating 'V'-shaped plow marks, direction of travel is to points of Vs

Width: ~8 cm

Trace maker: Asteroid? Reference: Durden (*in prep.*)

Rover images: A Tripod images: none



### Narrow raised track

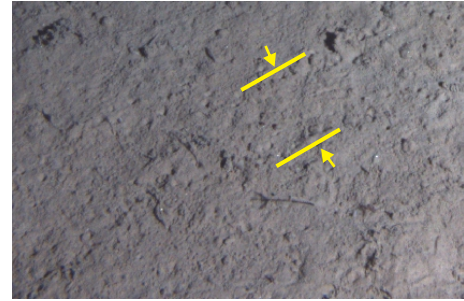
Group: Locomotory traces (tracks)

Description: Narrow, raised track furrowed/broken along crest

Width: ~1 cm Similar to: Narrow single groove track Trace maker: ?Bivalve

Reference: Heezen and Hollister 1971; similar to 'Group IIIA13' Ewing and Davis 1967

Rover images: A Tripod images: none



### Sparse tube feet impressions

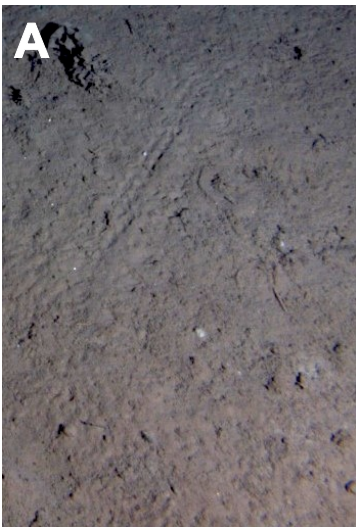
Group: Locomotory traces (tracks)

Description: Track of sparse tube feet impressions, generally in two rows

Width: ~6 cm Trace maker: Synallactidae gen. et sp. indet., ?*Peniagone* sp., ?

*Scotoplanes* sp., ?*Paroriza* sp. Reference: Heezen and Hollister, 1971; Durden *in prep.*

Rover images: A Tripod images: none



### Dense tube feet impression

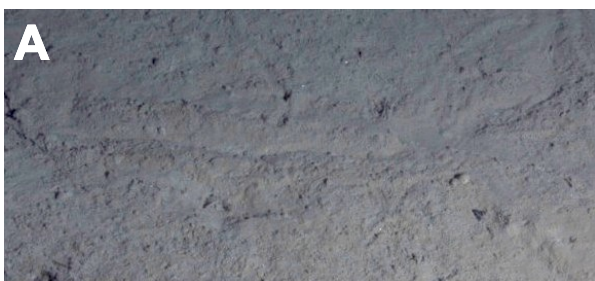
Group: Locomotory traces (tracks)

Description: Dense tube feet impressions in four rows Width: ~7 cm

Reference: "four-row trail" Heezen and Hollister, 1971; part of 'complex trail' Dundas 2009, Durden *in prep.* Trace maker: *Psychropotes* sp., *Paelopatides* sp., *Benthodytes* sp.

Rover images: A Tripod images: none





**V-shaped groove**

Group: Locomotory traces (tracks)

Description: Wide plowed v-shaped groove with gently sloping sides

Width: ~6 cm Similar to: TrackH

Trace maker: buried ?bivalve Reference: Durden *in prep.*

Rover images: A, B Tripod images: none



**Single groove**

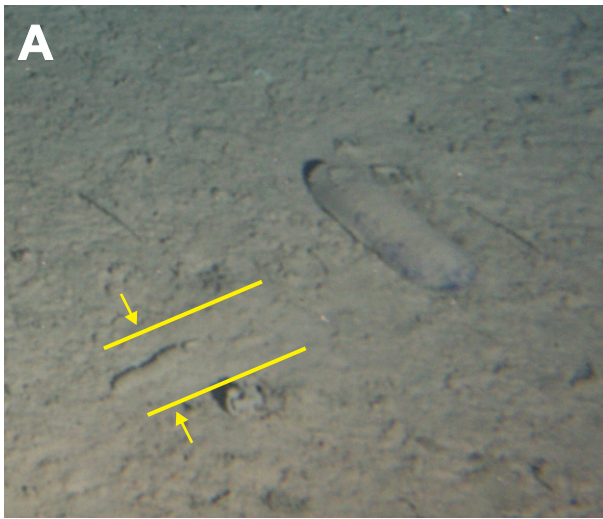
Group: Locomotory traces (tracks)

Description: Intermediate-width plowed groove, like a finger was drawn through sediment

Width: ~1 cm Similar to: Narrow single groove

Trace maker: Cnidarian pictured Reference: none (similar traces of different origin)

Rover images: A, B, C Tripod images: none



### Shallow wide depression

Group: Locomotory traces (tracks)

Description: Smooth, shallow, wide depression

Width: ~4 cm Trace maker: *Paelopatides* sp., *Pseudostichopus mollis*

Reference: 'smooth plow' Young *et al.* 1985; Durden *in prep.*

Rover images: B Tripod images: A



### Narrow single groove

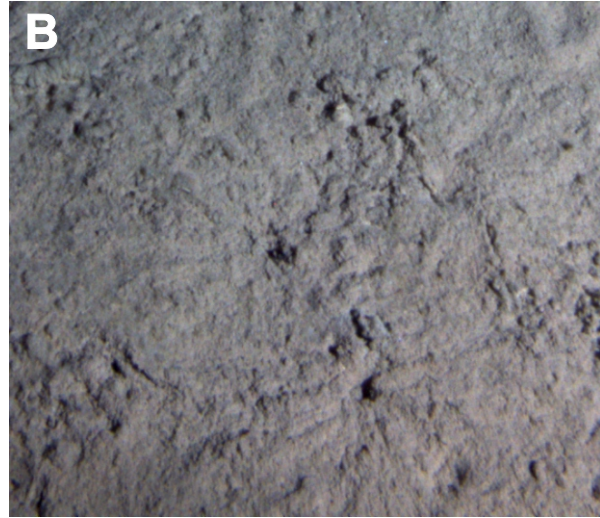
Group: Locomotory traces (tracks)

Description: Narrow single plowed groove

Width: ~1 cm Similar to: Single groove

Reference: similar to 'Group IIIA13' Ewing and Davis 1967; Durden *in prep.*

Rover images: A, B Tripod images: none



### Spoke burrow cluster

Group: Burrows and holes

Description: Central hole with plowed 'spokes' radiating from it; 'short' = holes spaced at intervals  $< 2$  spoke lengths, 'long' = holes spaced  $> 2$  spoke lengths apart

Trace maker: infauna Reference: Bett et al. 1995; 'pincushion rosette'

Dundas 2009; Ohta 1984; Durden *in prep.* Rover images: A,B Tripod images: none



### Rayed mound

Group: Burrows and holes

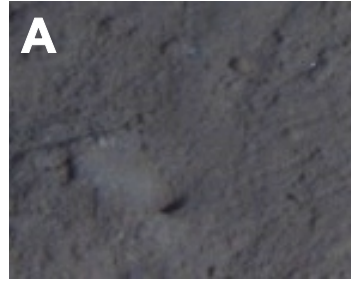
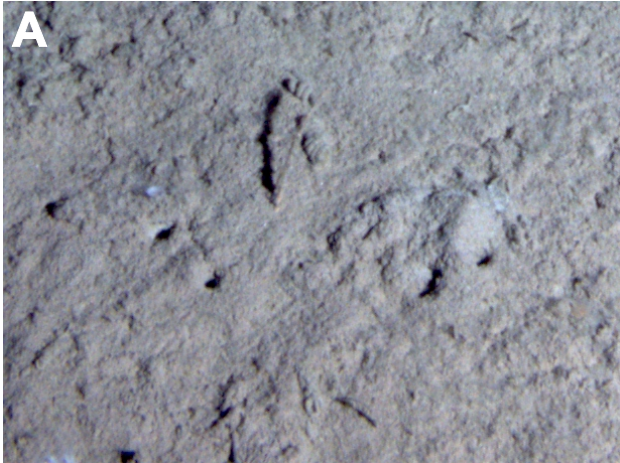
Description: Hemispherical mound with small irregular grooves radiating to twice diameter

Trace maker: ?polychaete (Glover, pers. comm.); not foraminiferan (Gooday, pers. comm.)

References: Gage and Tyler 1991; 'Group IIIB6' Ewing and Davis 1967; Durden *in prep.*

Dundas *et al.* 2009; Young *et al.* 1985 Rover images: A Tripod images: none





### Hole

Group: Burrows and holes

Description: Any type of hole in sediment without mound - single holes, or those in pairs or groups Trace maker: Infauna

Reference: 'single burrow' Dundas et al. 2009; Durden *in prep.*

Rover images: A, B Tripod images: not shown



### Hole pair

Group: Burrows and holes

Description: Conical sediment mound (lighter in colour) with hole at apex and second hole on flank or base of cone

Similar to: 'cone' Kitchell *et al.* 1978; Durden *in prep.* Trace maker: infauna

Reference: similar to those seen at PAP Rover images: A Tripod images: none



### Asteroid feeding depression

Group: Feeding traces

Description: Pentagonal depression with straight arms

Size: ~85 cm<sup>2</sup> Trace maker: Asteroid Reference: 'Star impression' Bell et al. 2012; 'Group III B1' Ewing and Davis 1967; 'star' Young *et al.* 1985; Durden *in prep.*

Rover images: B,C,D Tripod images: A



### Fecal mound

Group: Fecal matter

Description: Mound of piled thin fecal casting

Trace maker: unknown Reference: none

Rover images: A, B Tripod images: none



### Coiled cast

Group: Fecal matter

Description: Loose coil of bumpy 'string of pearls' cast, often with a 'tail', coil flat not round

Trace maker: *Psychropotes* sp. Reference: Heezen and Hollister 1971;

Dundas 2009 ('Coiled faecal casts'); 'Group IIA5' Ewing and Davis 1967; Durden *in prep.*

Rover images: A,B Tripod images: none



### Knotted cast

Group: Fecal matter

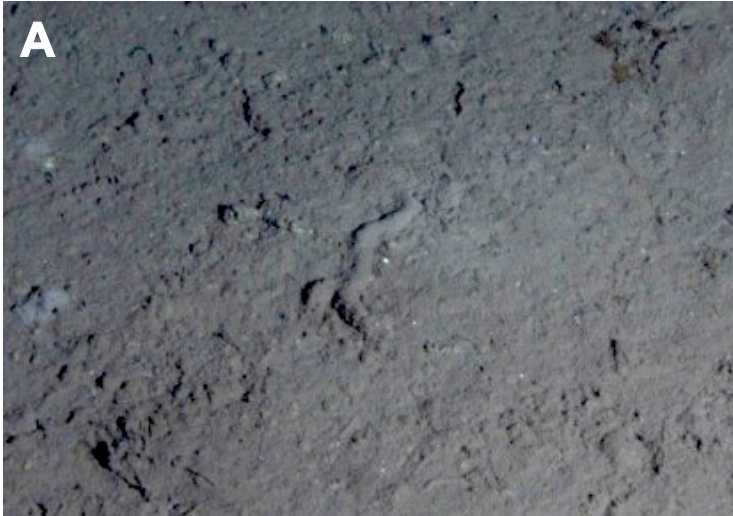
Description: Elongate smooth cylindrical cast of tightly grouped rings, occasionally with tail

Trace maker: ?Holothurian

Reference: Heezen and Hollister 1971; 'Group IIA4' Ewing and Davis 1967

Rover images: A,B Tripod images: none





### Smooth cast

Group: Fecal matter

Description: Smooth cylindrical cast

Trace maker: unknown Reference: Dundas *et al.* 2009; Durden *in prep.*

Rover images: A Tripod images: none



### Enteropneust cast

Group: Fecal matter

Description: Cylindrical fecal cast; split in VARS into 'hairpin', 'spiral' and 'mixed'

Reference: 'Group IA1' Ewing and Davis 1967; Heezen and Hollister 1971;

Smith *et al.* 2005; 'acorn worm coil' and 'acorn worm switchback' Dundas *et al.* 2009

Trace maker: Enteropneust Rover images: B Tripod images: A





### Crater

Group: Unknown origin

Description: Hemispherical crater

Trace maker: unknown

Reference: Kitchell *et al.* 1978; similar to 'crater' Young *et al.* 1985; Durden *in prep.*

Rover images: A Tripod images: none



### Irregular-shaped scar

Group: Unknown origin

Description: Irregular-shaped scar revealing subsurface sediment

Trace maker: unknown Reference: Dundas 2009; Durden *in prep.*

Rover images: B Tripod images: A