

**Appendix DR1. *Macaronichnus* occurrences through geologic time.**

| Reference <sup>1</sup>        | Age              | Unit / Location  | Depositional environment      | Paleolatitude <sup>2</sup> |
|-------------------------------|------------------|--|-------------------------------|----------------------------|
| Bromley (1996)                | Permian          | Offshore, Norway   | Foreshore                     | Temperate to subtropical/N |
| Bann et al. (2004)            | Lower Permian    | Pebbly Beach Fm., Sydney Basin, Australia                        | Shoreface to foreshore        | Temperate to subartic/S    |
| Bann and Fielding (2004)      | Lower Permian    | Lower Aldebaran Sandstone, Denison Trough, Queensland, Australia | Delta front to mouth bar      | Temperate to subartic/S    |
|                               | Upper Permian    | Freitag Fm., Denison Trough, Queensland, Australia               | Delta front to mouth bar      | Temperate to subartic/S    |
| Tye et al. (1999)             | Triassic         | Ivishak Fm., Alaska, USA   | Delta front                   | Temperate/N                |
| MacEachern et al. (2005)      | Middle Jurassic  | Tarbert and Oseberg Fms., Offshore, Norway                       | Delta front                   | Temperate/N                |
| McIlroy (2007)                | Middle Jurassic  | Lajas Fm., Neuquén Basin, Argentina                              | Delta front to mouth bar      | Temperate/S                |
| Heinberg (1974)               | Jurassic         | <i>Pecten</i> Sandstone, Milne Land, East Greenland              | Nearshore                     | Temperate/N                |
| Pemberton and Gingras (2005)  | Lower Cretaceous | Toro Sandstone, Papua, New Guinea                                | Shoreface                     | Temperate/S                |
| Pollard et al. (1993)         | Lower Cretaceous | Woburn Sands Fm. Southern England                                | Large-scale subtidal sandbars | Temperate to subtropical/N |
| Pemberton et al. (2001)       | Lower Cretaceous | Avalon Fm., Jeanne d' Arc Basin, Newfoundland, Canada            | Shoreface                     | Temperate to subtropical/N |
|                               | Lower Cretaceous | Cadotte Member, Peace River Fm., Alberta, Canada                 | Foreshore                     | Temperate/N                |
| MacEachern and Gingras (2007) | Lower Cretaceous | Bluesky Fm., Alberta, Canada                                     | Shoreface                     | Temperate/N                |
| Coates and MacEachern (2007)  | Lower Cretaceous | Viking Formation, Alberta, Canada                                | Shoreface                     | Temperate/N                |
| Gingras et al. (2002)         | Upper Cretaceous | Horseshoe Canyon Fm., Alberta, Canada                            | Foreshore                     | Temperate/N                |
| Reid and Pemberton (2007)     | Upper Cretaceous | Doe Creek Member, Kaskapau Fm., Alberta Canada                   | Shoreface and delta front     | Temperate/N                |
| MacEachern et al. (2005)      | Upper Cretaceous | Frontier, Harlan, Posey and Willow Fms., Wyoming, USA            | Delta front to mouth bar      | Temperate/N                |
|                               | Upper Cretaceous | Blackhawk Fm., Utah, USA   | Delta front                   | Temperate/N                |

|   |                                  |   |                                       |                            |
|---|----------------------------------|---|---------------------------------------|----------------------------|
|   | Upper Cretaceous                 | Belly River and Dunvegan Fms., Alberta, Canada                        | Delta front                           | Temperate/N                |
| <b>Gani et al. (2007)</b>                         | Upper Cretaceous                 | Ferron Sandstone Member, Mancos shale Fm., Book Cliffs, Utah, USA     | Shoreface and delta front             | Temperate/N                |
| <b>Curran (1985)</b>                              | Upper Cretaceous                 | Englishtown Fm., New Jersey, USA                                      | Nearshore, shoaling                   | Temperate/N                |
| <b>Savarda &amp; Uddin (2005)</b>                 | Upper Cretaceous                 | Eutaw Fm., Alabama, USA   | Tidal-inlet sandbars                  | Temperate to Subtropical/N |
| <b>Clifton &amp; Thompson (1978)</b>              | Upper Cretaceous                 | Mt. Laurel Fm., Runnemede New Jersey, USA                             | Nearshore                             | Temperate/N                |
| <b>Olivero et al (2007); Olivero et al (2008)</b> | Late Middle Eocene               | Leticia Fm., Tierra del Fuego, Argentina                              | Nearshore                             | Subartic to Artic/S        |
| <b>Chiesa (1996)<sup>3</sup></b>                  | Middle Eocene to Lower Oligocene | Chacay Fm., Southern Patagonia, Argentina                             | Nearshore                             | Temperate to subartic/S    |
| <b>DeCelles (1987)</b>                            | Lower Oligocene                  | Upper San Emigdio Fm., San Joaquin Basin, California, USA             | Shoreface to foreshore                | Temperate to subtropical/N |
|   | Upper Oligocene                  | Pleito Fm., San Joaquin Basin, California, USA                        | Shoreface to foreshore                | Temperate to subtropical/N |
|   | Lower Miocene                    | Lower Temblor Fm., San Joaquin Basin, California, USA                 | Shoreface to foreshore                | Temperate to subtropical/N |
| <b>Uchman and Krenmayr, (2004)</b>                | Lower Miocene                    | Upper Austria Molasse   | Shallow subtidal                      | Temperate/N                |
| <b>Carmona et al. (2008)</b>                      | Lower Miocene                    | Chenque Fm., Patagonia, Argentina                                     | Upper shoreface and subtidal sandbars | Temperate/S                |
| <b>Clifton &amp; Thompson (1978)</b>              | Lower Miocene                    | Vaqueros Fm., Santa Lucia Range, California, USA                      | Nearshore                             | Temperate/N                |
|   | Middle Miocene                   | Branch Canyon Sandstone, Southeastern Caliente Range, California, USA | Nearshore                             | Temperate/N                |
| <b>Kotake (2007)</b>                              | Middle Miocene                   | Yonaguni Fm., Yonaguni-jima Island, Southwest Japan                   | Shoreface                             | Temperate to subtropical/N |
| <b>Encinas et al., (2008)</b>                     | Upper Miocene                    | Navidad Fm. South-central Chile                                       | Foreshore                             | Temperate to subtropical/S |
| <b>Clifton &amp; Thompson (1978)</b>              | Pleistocene                      | Marine terrace deposits, Otter Point, Oregon, USA                     | Nearshore                             | Temperate/N                |
|   | Pleistocene                      | Marine terrace deposit, Monterrey Bay, California, USA                | Foreshore                             | Temperate/N                |
| <b>Gibert et al. (2006)</b>                       | Pleistocene                      | Chui Fm., Southern Brazil   | Very shallow subtidal                 | Temperate to subtropical/S |
| <b>D'alessandro and Uchman (2007)</b>             | Lower Pleistocene                | Tursi Sandstone, Southern Italy                                       | Shoreface                             | Temperate/N                |

|  |                               |   |                         |             |
|--|-------------------------------|---|-------------------------|-------------|
| <b>Nara (1998)</b>                         | Middle Pleistocene            | Kongochi Fm., Chiba Prefecture, Japan                                       | Foreshore               | Temperate/N |
| <b>Kamada (2008)</b>                       | Middle Pleistocene            | Outcrops at Doba River, Aomori Prefecture, Japan                            | Foreshore               | Temperate/N |
| <b>Seike (Written communication, 2008)</b> | Middle Pleistocene            | Wakimoto Fm., Akita Prefecture, Japan                                       | Foreshore               | Temperate/N |
|  | Middle Pleistocene            | Tanabu Fm., Aomori Prefecture, Japan  | Foreshore               | Temperate/N |
|  | Upper Pleistocene             | Shibikawa Fm., Akita Prefecture, Japan                                      | Foreshore               | Temperate/N |
| <b>Okazaki and Masuda (1992)</b>           | Upper Pleistocene             | Kioroshi Fm., Chiba Prefecture, Japan                                       | Foreshore               | Temperate/N |
| <b>Sakai, et al., (2006)</b>               | Upper Pleistocene to Holocene | Marine terrace deposits, Isumi River lowland, central Boso Peninsula, Japan | Foreshore               | Temperate/N |
| <b>Gregory et al., (2008)</b>              | Holocene                      | Beach ridges, One Tree Point, Northland, New Zealand                        | Foreshore and shoreface | Temperate/S |
| <b>Bromley et al. (2009)</b>               | Holocene                      | Beachrock, Rhodes Island, Greece  | Foreshore               | Temperate/N |
| <b>Clifton &amp; Thompson (1978)</b>       | Holocene                      | Sandbars of main channel, Willapa Bay, Washington, USA                      | Tidal sandbars          | Temperate/N |
| <b>Pemberton et al. (2001)</b>             | Holocene                      | Beach sediments at Long Island, Vancouver, Canada                           | Foreshore               | Temperate/N |
| <b>Seike (2007, 2008)</b>                  | Holocene                      | Beach sediments at Hasaki Coast, Japan                                      | Foreshore               | Temperate/N |

Notes:

- 1 Burrows referred to as *Macaronichnus segregatis* from the Lower Ordovician of England (Orr and Howe, 1999) display meniscate infill, which is not present in this ichnotaxon. They are present in deep-marine turbidites. Burrows described as *Macaronichnus segregatis* from the Pennsylvanian Fountain Formation of Colorado (Maples and Suttner, 1990) are isolated rather than forming densely packed assemblages which are typical of *Macaronichnus*. In addition, they occur in sandstone encased in finer-grained offshore deposits, an uncommon setting for *Macaronichnus*. Both occurrences are removed from *Macaronichnus*.
- 2 Paleolatitudinal data was obtained from Scotese (2001). Latitudinal division: Tropical 0° - 23.5° N/S, Temperate 23.5° - 66.6° N/S and Arctic > 66.6° N/S. Subtropical 20° - 35° N/S and Subarctic 50° - 70° N/S.
- 3 The age of the Chacay Formation is debatable. It is regarded as coeval with the San Julian Formation by stratigraphic relationship and faunal similarities (Chiesa and Camacho, 1995), but foraminifera data place the latter in the Upper Eocene-Lower Oligocene and palynomorphs in the Oligocene (Del Río & Martínez, 2006 and references therein).

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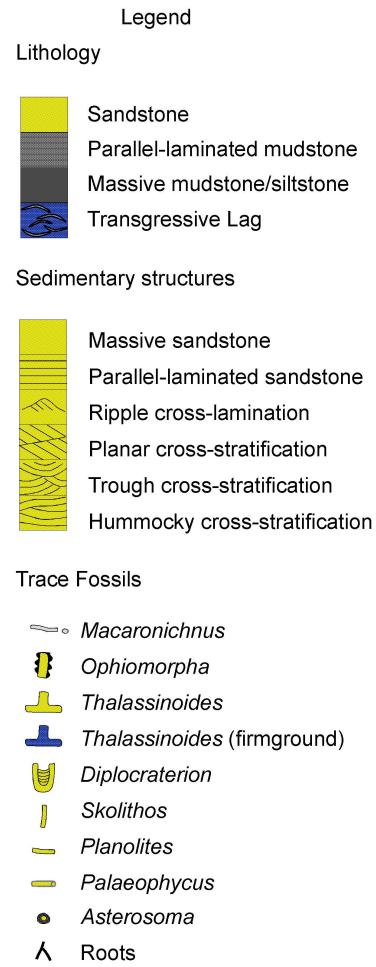
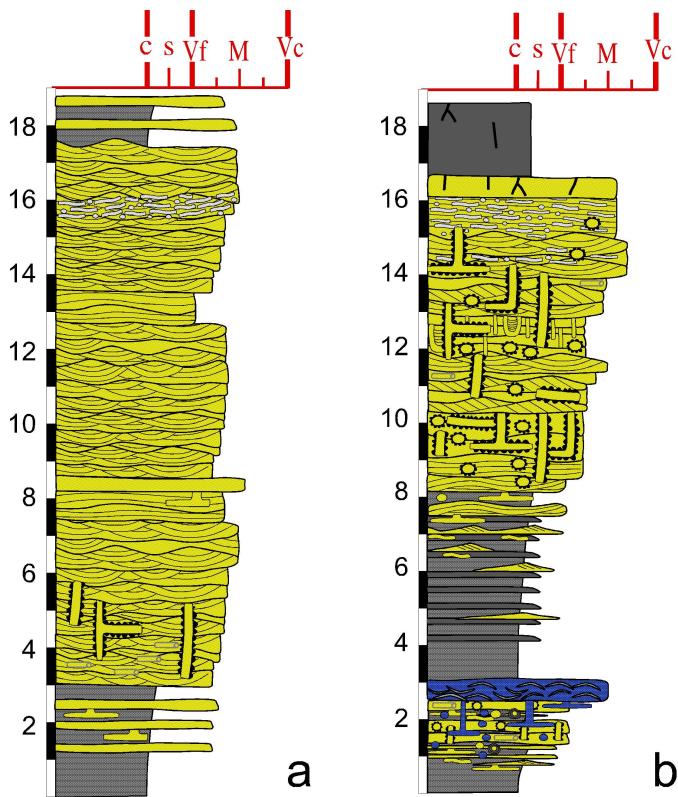
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APPENDIX B: Sedimentologic logs for the *Macaronichnus*-bearing deposits in the Naricual (a) and Urumaco (b) formations.