SUPPLEMENTARY DATA:

RESOLUTION OF THE EARLY JURASSIC ACTINOPTERYGIAN FISH PACHYCORMUS AND A DISPERSAL HYPOTHESIS FOR PACHYCORMIFORMES

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TABLE S1. Maximum body length and cranium measurements (mm) for specimens of *Pachycormus curtus* (n=8), *P. macropterus* (n=3), *P. bollensis* (n=6), and *Pachycormus* sp. (n=14).

| Catalog number | Species             | Maximum Body Length | Cranium | Ratio |
|----------------|---------------------|---------------------|---------|-------|
| GPIT/74332-4   | *P. curtus*         | 256                 | 66      | 3.9:1 |
| SMNS 87771     | *P. curtus*         | 200                 | 57      | 3.5:1 |
| SMNS 96618     | *P. curtus*         | 260                 | 55      | 4.7:1 |
| SMNS 55300     | *P. curtus*         | 380                 | 94      | 4:1   |
| SMNS 87762     | *P. curtus*         | 310                 | 80      | 3.8:1 |
| PMU 24211      | *P. curtus*         | 380                 | 94      | 4:1   |
| UMH unregistered specimen 1 | *P. curtus* | 500                 | 125     | 4:1   |
| UMH unregistered specimen 2 | *P. curtus* | 370                 | 105     | 3.5:1 |
| UMH unregistered specimen 3 | *P. macropterus* | 530                 | 135     | 3.9:1 |
| P7569 (BMNH)   | *P. macropterus*    | 670                 | 179     | 3.7:1 |
| P12913 (BMNH)  | *P. macropterus*    | 520                 | 135     | 3.9:1 |
| GPIT/OS/777    | *P. bollensis*      | 850                 | 250     | 3.4:1 |
| GPIT/OS/776    | *P. bollensis*      | 890                 | 210     | 4.2:1 |
| UMH unregistered specimen 4 | *P. bollensis* | 890                 | 235     | 3.8:1 |
| UMH unregistered specimen 5 | *P. bollensis* | 750                 | 174     | 4.3:1 |
| UMH unregistered specimen 6 | *P. bollensis* | 750                 | 190     | 3.9:1 |
| PMU 24210      | *P. bollensis*      | 860                 | 235     | 3.7:1 |
| SMNS 87772     | *Pachycormus* sp.   | 420                 | 120     | 3.5:1 |
| SMNS 87763     | *Pachycormus* sp.   | 300                 | 74      | 4.1:1 |
| SMNS 95835     | *Pachycormus* sp.   | 410                 | 106     | 3.9:1 |
| SMNS 65230     | *Pachycormus* sp.   | 420                 | 110     | 3.8:1 |
| SMNS 51031     | *Pachycormus* sp.   | 575                 | 140     | 4.1:1 |
| SMNS 18189     | *Pachycormus* sp.   | 245                 | 74      | 3.3:1 |
| UMH unregistered specimen 7 | *Pachycormus* sp. | 1020                | 275     | 3.7:1 |
| UMH unregistered specimen 8 | *Pachycormus* sp. | 635                 | 168     | 3.8:1 |
| UMH unregistered specimen 9 | *Pachycormus* sp. | 483                 | 130     | 3.7:1 |
| UMH unregistered specimen 10 | *Pachycormus* sp. | 490                 | 90      | 5.4:1 |
| UMH unregistered specimen 11 | *Pachycormus* sp. | 350                 | 88      | 4:1   |
| UMH unregistered specimen 12 | *Pachycormus* sp. | 920                 | 190     | 4.8:1 |
| UMH unregistered specimen 13 | *Pachycormus* sp. | 850                 | 220     | 3.9:1 |
| UMH unregistered specimen 14 | *Pachycormus* sp. | 895                 | 210     | 4.7:1 |
**TABLE S2.** Cranium and preorbital measurements (mm) for specimens of *Pachycormus curtus* (n=8), *P. macropterus* (n=5) *P. bollensis* (n=7), and *Pachycormus* sp. (n=17).

| Catalog number | Species | Cranium | Preorbital | Ratio |
|----------------|---------|---------|------------|-------|
| GPIT/74332-4   | *P. curtus* | 66      | 29         | 2.3:1 |
| SMNS 87771     | *P. curtus* | 57      | 24         | 2.4:1 |
| SMNS 96618     | *P. curtus* | 55      | 15         | 3.7:1 |
| SMNS 55300     | *P. curtus* | 94      | 27         | 3:1   |
| SMNS 87762     | *P. curtus* | 80      | 38         | 2:1   |
| PMU 24210      | *P. curtus* | 94      | 37         | 2.5:1 |
| UMH unregistered specimen 1 | *P. curtus* | 125     | 36         | 3:1   |
| UMH unregistered specimen 2 | *P. curtus* | 105     | 37         | 2.2:1 |
| GPIT/773       | *P. macropterus* | 139    | 47         | 3:1   |
| GPIT/774       | *P. macropterus* | 110    | 43         | 2.5:1 |
| UMH unregistered specimen 3 | *P. macropterus* | 135    | 50         | 3:1   |
| P7569 (BMNH)   | *P. macropterus* | 179    | 73         | 2.5:1 |
| PI2913 (BMNH)  | *P. macropterus* | 135    | 44         | 3:1   |
| GPIT/OS/777    | *P. bollensis* | 250    | 100        | 2.5:1 |
| GPIT/OS/776    | *P. bollensis* | 210    | 80         | 2.5:1 |
| UMH unregistered specimen 4 | *P. bollensis* | 235    | 85         | 3:1   |
| UMH unregistered specimen 15 | *P. bollensis* | 168    | 60         | 3:1   |
| UMH unregistered specimen 5 | *P. bollensis* | 174    | 70         | 2.5:1 |
| UMH unregistered specimen 6 | *P. bollensis* | 190    | 70         | 2.5:1 |
| PMU P1191      | *P. bollensis* | 235    | 91         | 2.5:1 |
| SMNS 87769     | *Pachycormus* sp. | 180    | 76         | 2.5:1 |
| SMNS 87772     | *Pachycormus* sp. | 120    | 40         | 3:1   |
| SMNS 87763     | *Pachycormus* sp. | 74     | 30         | 2.5:1 |
| SMNS 87760     | *Pachycormus* sp. | 50     | 16         | 3:1   |
| SMNS 95835     | *Pachycormus* sp. | 106    | 45         | 2.5:1 |
| SMNS 53425     | *Pachycormus* sp. | 240    | 90         | 2.5:1 |
| SMNS 65230     | *Pachycormus* sp. | 110    | 60         | 2:1   |
| SMNS 51031     | *Pachycormus* sp. | 140    | 54         | 3:1   |
| SMNS 18189     | *Pachycormus* sp. | 74     | 29         | 2.5:1 |
| UMH unregistered specimen 7 | *Pachycormus* sp. | 275    | 90         | 3:1   |
| UMH unregistered specimen 8 | *Pachycormus* sp. | 168    | 54         | 3:1   |
| UMH unregistered specimen 9 | *Pachycormus* sp. | 130    | 60         | 2.2:1 |
| UMH unregistered specimen 10 | *Pachycormus* sp. | 90     | 43         | 2.1:1 |
| UMH unregistered specimen 11 | *Pachycormus* sp. | 88     | 37         | 2.4:1 |
| UMH unregistered specimen 12 | *Pachycormus* sp. | 190    | 80         | 2.4:1 |
| UMH unregistered specimen 13 | *Pachycormus* sp. | 220    | 80         | 2.8:1 |
| UMH unregistered specimen 14 | *Pachycormus* sp. | 210    | 85         | 2.5:1 |

**TABLE S3.** Opercular measurements (mm) for specimens of *Pachycormus curtus* (n=6) and *P. macropterus* (n=3).

| Catalog number | Species     | Length | Height | Ratio | Position of ventral angle |
|----------------|-------------|--------|--------|-------|---------------------------|
| P2037a (BMNH) | *P. curtus* | 40     | 20     | 2:1   | Midlength                 |
| 32435 (BMNH)  | *P. curtus* | 31.7   | 15.8   | 2:1   | Midlength                 |
| 32439 (BMNH)  | *P. curtus* | 41.2   | 20.6   | 2:1   | Midlength                 |
| 32427 (BMNH)  | *P. curtus* | 32.3   | 15.4   | 2.1:1 | Midlength                 |
| 32425 (BMNH)  | *P. curtus* | 32.3   | 20     | 1.6:1 | Midlength                 |
| P12913 (BMNH) | *P. macropterus* | 48.8   | 32.4   | 1.5:1 | Midlength                 |
| P7569 (BMNH)  | *P. macropterus* | 70     | 38     | 1.8:1 | Midlength                 |
| GPIT/774      | *P. macropterus* | 36     | 20     | 1.8:1 | Midlength                 |
| GPIT/OS/776   | *P. bollensis* | 45     | 25     | 1.8:1 | Anterior to midlength    |
FIGURE S1. Examples of *Pachycormus* from the UMH illustrating morphotype variation: (A) unregistered specimen 2, *P. curtus*; (B) unregistered specimen 5, *P. bollensis*; (C) unregistered specimen 6, *P. bollensis*; (D) unregistered specimen 11, *Pachycormus* sp. Scales equal 50 mm. Additional photographs of other UMH specimens are available from the authors upon request.

FIGURE S2. Fixed anatomically corresponding landmarks designated for the relative warps analysis. Only skeletally complete specimens (n=14) were assessed, with 2/14 (7%) lacking fully intact pectoral and caudal fins. Representative species labelled as *Pachycormus curtus* in the FMHS (unregistered specimen displayed behind glass and not accessible for study).

| RW | % variance | Cumulative % |
|----|------------|--------------|
| 1  | 36.09%     | 36.09%       |
| 2  | 27.62%     | 63.71%       |
| 3  | 15.14%     | 78.85%       |
| 4  | 6.49%      | 85.34%       |
| 5  | 5.47%      | 90.80%       |
Revised character scores (NEXUS format) for the Friedman (2012) pachycormiform matrix.

Pachycormus_macropterus
00101100000-00-0111000?0001010100001001-0101-
011001100000000100001?01010000000100000000001110100?110010011110110?11-000

Pachycormus_curtus
00101100000-00-0111000?0001010100001001-0101-
011001100000000100001?01010000000100000000001110(01)00?111001100111110?11-000

Pachycormus_bollensis
????????????????????????????????????????????????????????1000001?01-010--
01100011000001001000011?00????0????0?????0????10100?11100?01????110011-000

TABLE S5. Paleobiogeographical area state codes for pachycormiform taxa. A: Boreal Tethys; B: Western Interior Seaway; C: Eromanga Seaway; D: Western Pacific rim; E: Hispanic corridor; F: Proto−Atlantic; G: Equatorial Tethys; H: Eastern Pacific rim; I: Australasian Tethys; J: Eastern Atlantic rim. Reference literature: Mainwaring (1978); Stewart (1988); McNamara et al. (1993); Lambers (1992); Kear (2007); Kear et al. (2009); Friedman et al. (2010); Liston (2010); Arratia and Sclutze (2013); Friedman et al. (2013); Bazzi et al., (2015), Schumacher et al., (2016).

| Taxon                | Score         |
|---------------------|---------------|
| Asthenocormus       | 1001000000    |
| Australopachycormus | 001000000    |
| Bonnerichthys       | 0101000001    |
| Euthynotus          | 1000000000    |
| Hypocormus          | 1000000000    |
| Leedsichthys        | 1000000100    |
| Martillichthys      | 1000000000    |
| Ohmdenia            | 1000000000    |
| Orthocormus         | 1000000000    |
| Pachycormus         | 1000000000    |
| Protosphyraena      | 1100010010    |
| Rhinconichthys      | 1101000000    |
| Saurostomus         | 1000000000    |
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