The redescription of *Cheramomyzon abyssale* Humes, 1989 (Copepoda: Siphonostomatoida: Asterocheridae) and its position within the family

Johnsson, R. and Neves, E. G.

Universidade Federal da Bahia, Instituto de Biologia, Departamento de Zoologia, Av. Adhemar de Barros s/n, Ondina, 40170-290, Salvador – BA, Brasil. e-mail: johnsson@ufba.br

Abstract

The redescription of *Cheramomyzon abyssale* Humes, 1989 showed the existence of previously unobserved characters which may constitute important features within the Siphonostomatoida and help to elucidate relationships, not only among genera belonging to the family Asterocheridae but also among basal families of the order. The first character is a reduced distal seta on the inner margin of the third exopodal segment of legs 3 and 4, which was previously ignored. Although the presence of nine setae on the exopod is a common plesiomorphic feature within siphonostomatoid families such as Artotrogidae, it has never been found among the Asterocheridae. The second character is a small seta on the inner margin of the protopod of leg 5 which represents a vestige of the endopod of this leg. This feature is also a plesiomorphic character state within the siphonostomatoids and is found only in certain asterocherid genera. *Cheramomyzon* also shows plesiomorphic states for the mandibular palp and maxillule, bearing the maximum number of setae found anywhere in the Asterocheridae. The reduction of these previously unseen setae is unique, and has not been observed in any other family of Siphonostomatoida.

Key words: Asterocheridae, Siphonostomatoida, Copepoda, *Cheramomyzon*

Introduction

The Artotrogidae and Asterocheridae are the most plesiomorphic families of the order Siphonostomatoida. Although the former is a well defined taxon based mainly on the absence of the mandibular palp, the length ratio of the endopodal segments of the antenna, and the fusion patterns of the antennule segments (Holmes, 1998; Eiselt, 1961; Gotto, 1979), the latter has been used as a repository for genera and species which did not fit into the other families of the order. The presence of many plesiomorphic character states in the Asterocheridae indicates that it is necessary to review its genera and to identify apomorphic character states defining the family or synapomorphic groups within it. The family groups all genera that do not possess distinguishable character states that enable them to be placed elsewhere. The absence of particular seta from the exopods of legs 1 to 4 on most Asterocherids indicates a possible character state that may serve to differentiate between both families. However, the genus *Cheramomyzon* Humes, 1989, described from deep-sea hydrothermal vents on the East Pacific Rise (Humes, 1989), shows, in the original description, legs 1 and 2 with 8 and 9 elements respectively on the third exopodal segment, a setation identical to that observed in Artotrogidae. When re-examining the single species of this genus it was found that legs 3 and 4 in *Cheramomyzon* do not lack any setae and thus also have the same setation as the artotrogids, on legs 3 and 4 exopods. No other genus within Asterocheridae shows a similar pattern of reduced elements.

Material examined

Holotype female (MNHN-Cp634); two female paratypes (MNHN-Cp635), collected at 2630 m depth, at Genesis and Parigo (12°48.56'N – 103°56.48'W and 12°48.52'N – 103°56.48'W), "Nautile" dive n°221, 22/Nov./1987.

Cheramomyzon abyssale Humes, 1989.

Redescription

Female: Body length (excluding caudal setae) 2105 mm, greatest body width 626 mm; body 3.4 times longer than wide. Body cyclopiform (figs. 1a – b). Pedigerous somite 1 totally fused with cephalosome, with epimera moderately pointed and with margins ornamented with digitiform internal lobes (fig. 1f). Pedigerous somites 2 and 3 of similar length and with epimera moderately pointed. Ratio of length – width of prosome 1.8:1; ratio of length of prosome to that of urosome 1.3:1.

Genital double-somite (fig. 1c) 1.5 times longer than wide, rounded anterolaterally, with two setae located anteriorly on genital area (fig. 1d), and with groove medially. Three postgenital somites, all longer than wide, 1.3, 1.4 and 1.1:1. Anal somite with anal operculum medially in posterior region. Caudal rami elongate (fig. 1e), 6.3 times longer than wide: seta I absent, length ratio of setae II to VII: 2.1: 2.3: 6.4: 6.3: 2.3: 1. Setae II and VII smooth, setae III to VI plumose.

Antennule (fig. 2a) 645 mm long, not including setae, and 19-segmented. Length ratios of antennule articles: 6.8: 1.6: 1.3: 1.4: 1.1: 1.3: 1: 1.7: 2.9: 1.6: 1.9: 2.5: 2.5: 3.1: 2.9: 3.1: 3.8: 1.4: 4.2. Segmental homologies and setation as follows: Roman numerals indicate the original segments followed by the number of setae in Arabic, according to Huys & Boxshall (1991): I-2; II-2; III-2; IV-2; V-2; VI-2; VII-2; VIII-2; IX-XIII-7; XIV-1+spine; XV-2; XVI-2; XVII-2; XVIII-1; XIX-1; XX-2; XXI-1+ae; XXII-XXIII-2; XXIV-XXVIII-9. All setae smooth. Aesthetasc on segment XXI 100 mm long.

Antenna (fig. 2b) 643 mm long (including distal seta). Basis unarmed; exopod 3.2 times longer than wide, bearing three setae. Endopod 2-segmented (1.7:1), first segment unarmed; second segment with two long setae located proximally and subdistally, and distal setae, one close to terminal claw, which is 1.3 times longer than basis, and curved distally.

Oral cone (fig. 2c) 272 mm long, 0.2 times body length, pear-shaped, almost reaching insertion of maxilla. Mandible (fig. 2d) comprising stylet 250 mm long toothed distally, and palp 77 mm long, 2-segmented (1.8:1), armed with two plumose setae distally. Maxillule (fig. 2e) bilobed, outer lobe armed with four smooth distal setae; inner lobe 1.2 times longer than outer and armed with five smooth distal setae. Maxilla (fig. 2f) with claw 1.3 times longer than syncoxa, curved distally and carrying long seta and setules medio-proximally.

Maxilliped (fig. 2g) 5-segmented and with distally curved terminal claw (4.1: 5.2: 1: 3.5: 2.7: 5.2). Syncoxa with long seta on inner margin; basis with group of setules on lateral outer margin. First endopodal segment with two distal setae; second and third endopodal segments each with long distal seta.

Swimming legs 1-4 (P1-P4 figs. 3a-b, 4a-b) biramous, all with 3-segmented rami. Third exopodal segment of P3 and P4 showing small smooth seta located distally on inner margin. Armature formula of legs 1-4 as shown in table I.

Fifth leg (fig. 4c) 2-segmented. Protopod partially fused to fifth pedigerous somite and with one seta on outer margin and another on inner margin. Free segment with two setae on outer margin, one seta distally and one on inner margin.

Table I: *Cheramomyzon abyssale* Humes, 1989. Armature formula of legs 1 to 4.

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	I-1; I-1; III,2,3	0-1; 0-2; 1,2,3
Leg 2	0-1	1-0	I-1; I-1; III,I,5	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; I-1; III,I,5	0-1; 0-2; 1,2,3
Leg 4	0-1	1-0	I-1; I-1; III,I,5	0-1; 0-2; 1,I,2

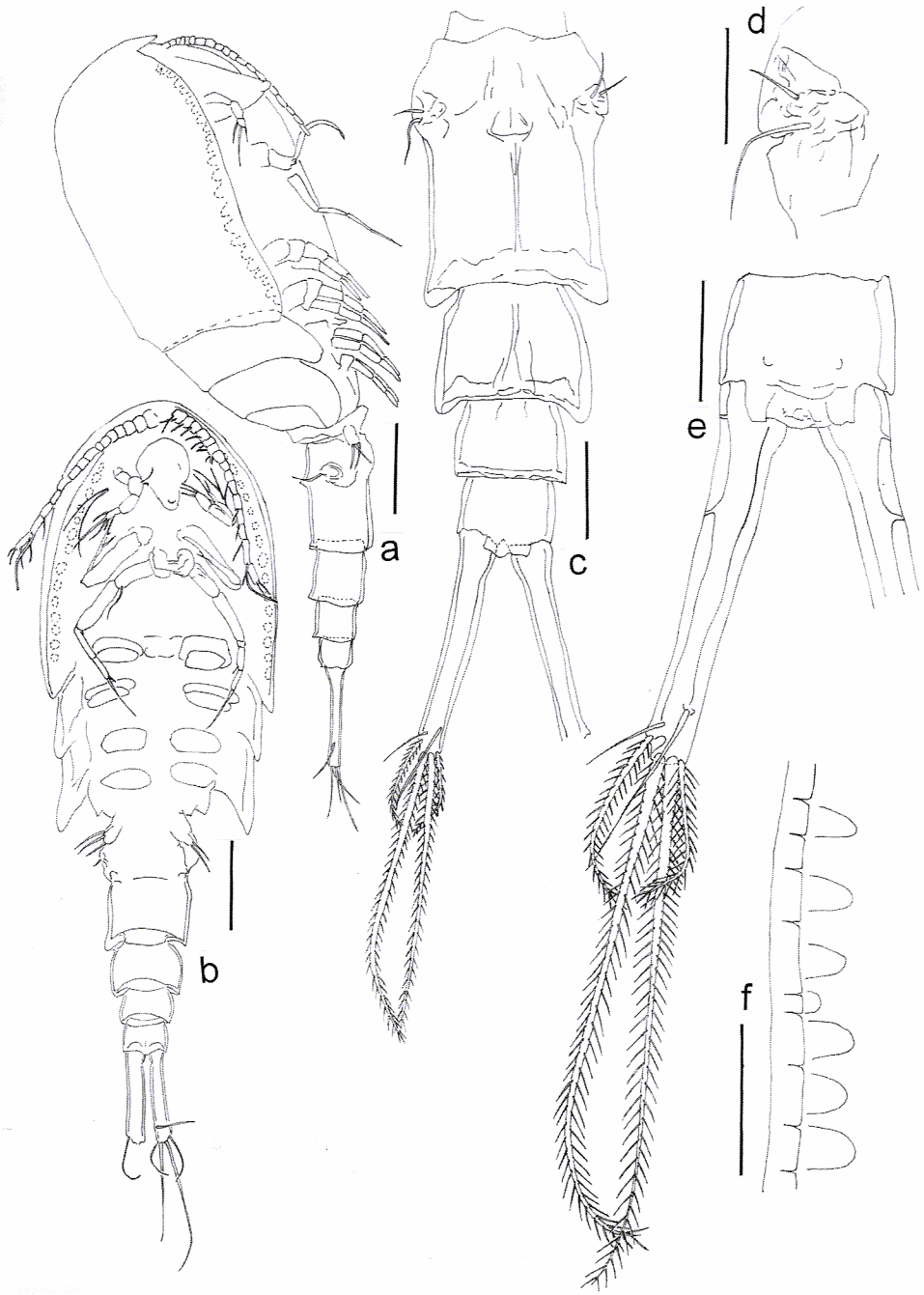

Figure 1: *Cheramomyzon abyssale* Humes, 1989. Female paratype: a) habitus, lateral view; b) habitus, ventral view; c) urosome; d) left gonopore with leg 6; e) left caudal ramus; f) cephalosome margin. Scale bars: a-b = 200 μm; c, e-f = 100 μm; d = 50 μm.

Remarks

This redescription demonstrates two main differences from the original description of Humes (1989) which are extremely important for future phylogenetic analyses of the group.

The first is the existence of the small distal setae on the inner margin of the third exopodal segment of P3 and P4. The formula III,I,5 found on the third exopodal segment of legs 2 to 4 of *Cheramomyzon* (figs. 3b, 4a, 4b) is a pattern shared only with the family Artotrogidae, among all Siphonostomatoida.

This pattern matches that observed among calanoid copepods in which the maximum leg setation is found. *Cheramomyzon*, as well as certain Artotrogidae, exhibit the most plesiomorphic legs among the entire Siphonostomatoida. Excluding *Cheramomyzon*, all other genera of Asterocheridae have only 8 elements on these segments of legs 3 and 4, matching the formula III,I,4.

The second difference is the presence of a small seta on the inner margin of the protopod of P5 which represents a vetige of the endopod of this leg. Two segments are only observed in the family Dinopontiidae, some genera of Dirivultidae and a few genera of the family Asterocheridae: *Collocheres, Collocherides, Glyptocheres, Scottocheres* and *Dermatomyzon*. However only the last two genera also possess the small seta representing the endopod (fig. 4c).

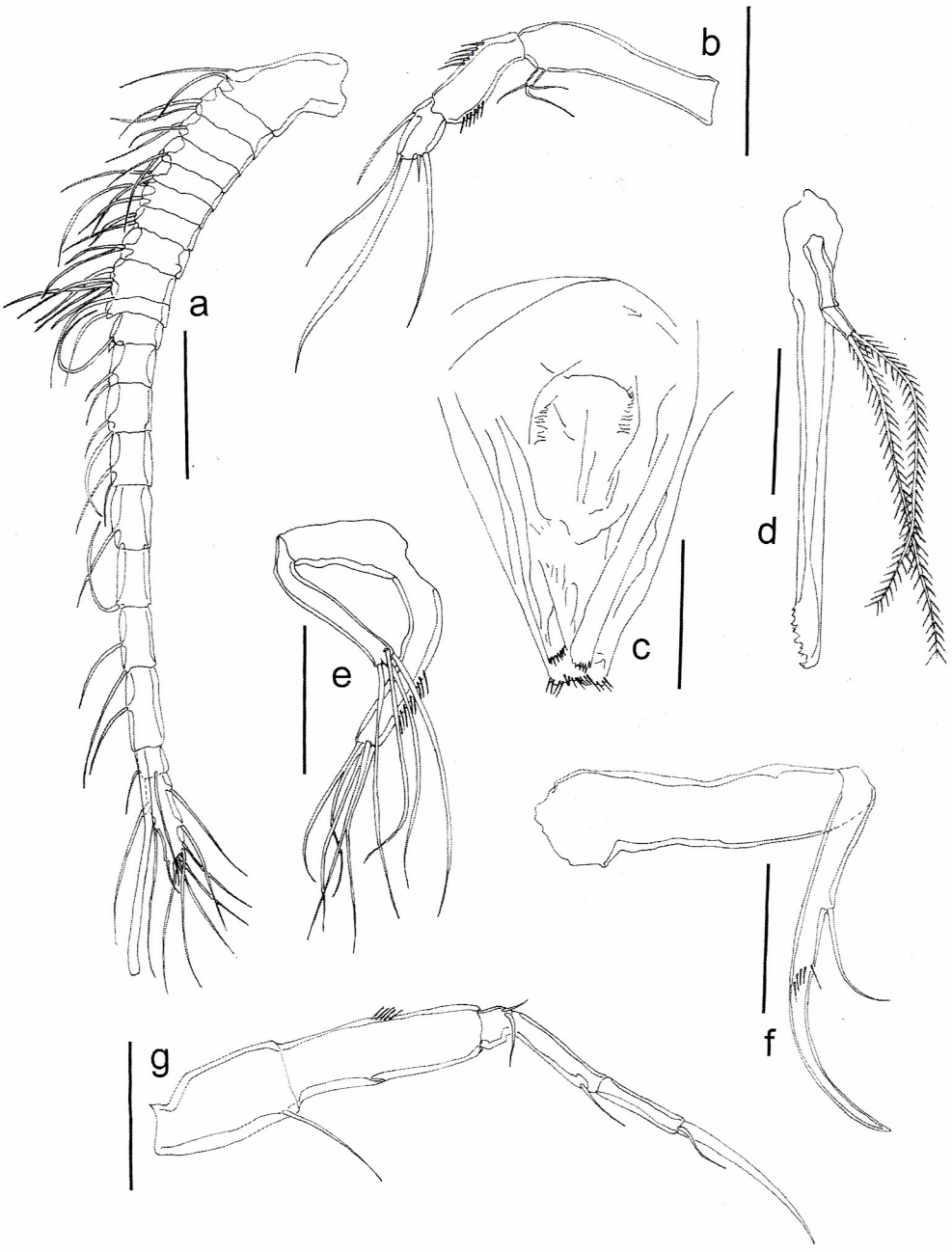

Figure 2: *Cheramomyzon abyssale* Humes, 1989. Female paratype: a) antennule; b) antenna; c) siphon; d) mandible; e) maxillule; f) maxilla; g) maxilliped. Scale bars: a-g = 100 µm.

The 2-segmented leg 5 and the existence of the small distal seta on the inner margin of the protopod indicate that, among other Siphonostomatoids, *Cheramomyzon* shows a highly plesiomorphic leg 5.

Cheramomyzon has many other plesiomorphic character states, such as the 2-segmented mandibular palp (fig. 2d), the absence of fusions involving the antennular segment XXI which is not distally located (fig. 2a), and the inner and outer lobes of the maxillule bearing 5 and 4 setae respectively (fig. 2e). These states are shared with the Asterocherids and serve to differentiate asterocherids from the artotrogids.

Cheramomyzon exhibits all the plesiomorphic character states that are shown in Asterocheridae and Artotrogidae, with the exception of the absence of the distal seta on the third endopodal segment of P4 (fig. 4b) (showing the formula 1,I,2 instead of 1,I+1,2) and endopodal segments II and III of the antenna are fused (fig. 2b).

It has been recognized that the family Asterocheridae is composed of numerous genera which do not fit into the remaining siphonostomatoid families. This is because the family is characterized mainly by plesiomorphic character states. One of the few potential exceptions is the absence of the seta on the exopod of legs 1 to 4 (in most of the species) and the absence of an aesthetasc on male antenule (commonly observed among male artotrogids). Therefore *Cheramomyzon* has many plesiomorphic character states which are found in the Asterocheridae and in the Artotrogidae but have never been observed simultaneously in any species. Future studies, based on phylogenetic analysis, may support the suggestion that *Cheramomyzon* should be placed in its own family, based on the reduction of the distal exopodal seta on the legs.

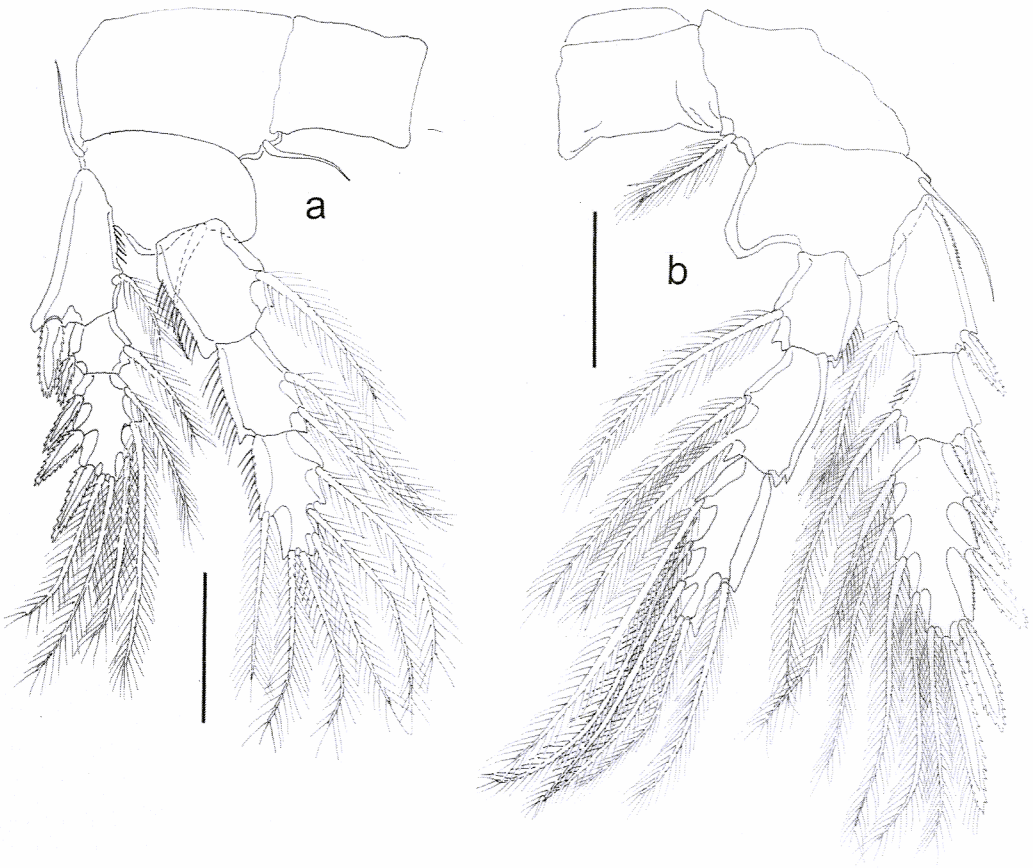

Figure 3: *Cheramomyzon abyssale* Humes, 1989. Female paratype: a) leg 1; b) leg 2. Scale bars: a-b = 100 µm.

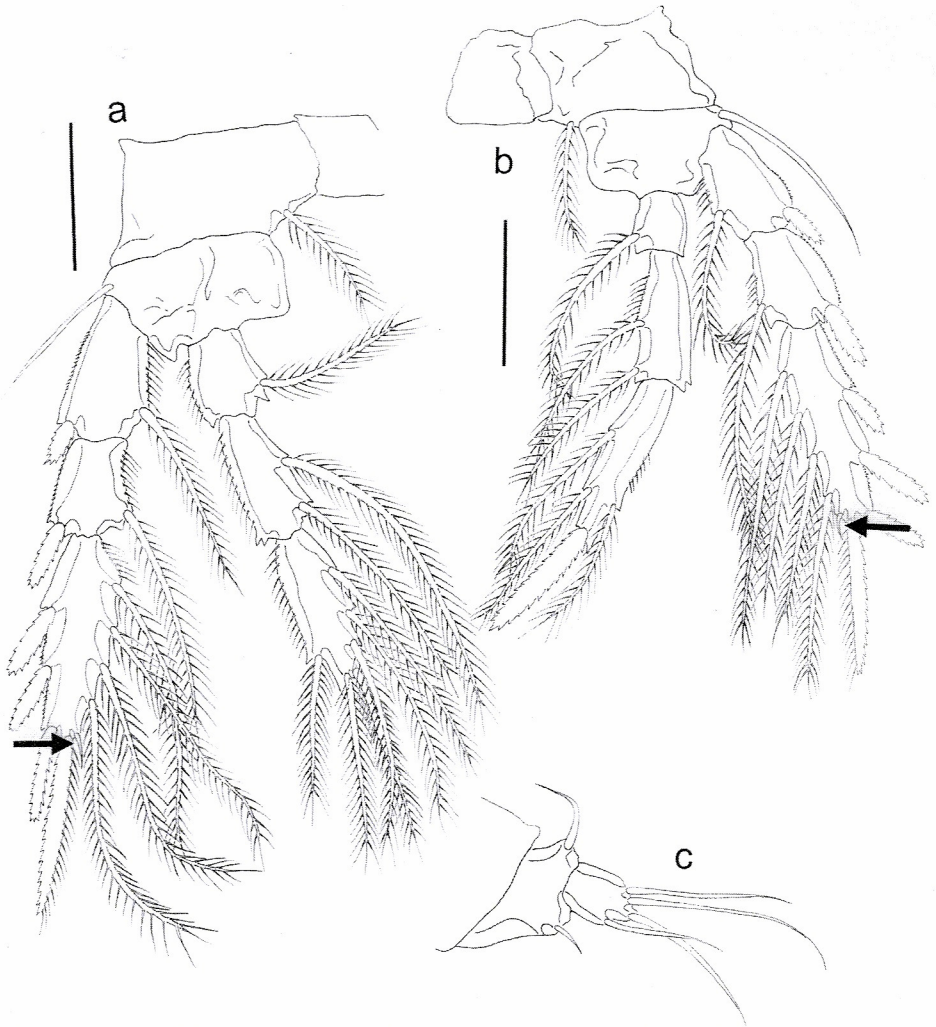

Figure 4: *Cheramomyzon abyssale* Humes, 1989. Female paratype: a) leg 3, black arrow indicates vestigial seta; b) leg 4, black arrow indicates vestigial seta; c) leg 5. Scale bars: a-c = 100 μm.

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