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Research article

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Mastigotragus, a new generic name for *Mastigoteuthis pyrodes* Young, 1972 (Cephalopoda: Mastigoteuthidae)

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Abstract. A recent paper on the phylogenetic relationships of species within the cephalopod family Mastigoteuthidae meant great progress in stabilizing the classification of the family. The authors, however, left the generic placement of *Mastigoteuthis pyrodes* unresolved. This problem is corrected here by placing this species in a new monotypic genus, *Mastigotragus*, based on unique structures of the photophores and the funnel/mantle locking apparatus.

Keywords. Mastigoteuthidae, morphology, nomenclature, *Mastigotragus* gen. nov., deep-sea squid

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Introduction

The squid family Mastigoteuthidae contains oceanic, mostly bathypelagic, species that are soft bodied and easily damaged in trawls. The inaccessibility of species and their fragile nature are in large degree responsible for problems in the classification of this family. Little consistency has existed between classifications, even with the same senior author (e.g., Salcedo-Vargas & Okutani 1994 and Salcedo-Vargas 1997). In a revision of the family on the Tree of Life website, Vecchione *et al.* (2004, with subsequent modifications up to 2014) suggested, because of the uncertainties in classification, "… that modifying the classification is premature and should wait until our knowledge has increased to the point where a full phylogenetic study can be made. We recognize, therefore, only the single genus *Mastigoteuthis*." Vecchione *et al*. (2004–2014) then placed species (excluding species of doubtful validity and those known only from paralarvae; see below) into the following six species groups: *Mastigoteuthis agassizii* group (three-species group), *M. cordiformis* (one-species group), *M. glaukopis* group (three-species group), *M. hjorti* (one-species group), *M. magna* group (two-species group) and *M. pyrodes* (one-species group). The excluded species from the Vecchione *et al.* species groups are: *Mastigoteuthis*

latipinna (Sasaki, 1916), *M. islini* MacDonald & Clench, 1934, *M. inermis* Rancurel, 1972, *M. okutani* (Salcedo-Vargas, 1997) and *Chiroteuthoides hastula* Berry, 1920.

The phylogenetic study that was called for by Vecchione *et al.* (2004-2014) to establish a proper classification for the Mastigoteuthidae has now been published by Braid *et al*. (2014). Those authors analyzed three mitochondrial genes from 29 mastigoteuthid squids in eight species and re-examined morphological characters. Their results agreed with the species groups established by Vecchione *et al*. (2004-2014) and enabled them to establish a formal generic classification for the family that utilized generic and subgeneric names previously present in the literature. The following table compares these two classification systems:

Comparison of classifications

	Vecchione *et al.* 2004–2014	Braid *et al.* 2014
1	The *Mastigoteuthis agassizii* group	*Mastigoteuthis* spp.
2	*Mastigoteuthis cordiformis*	*Idioteuthis cordiformis*
3	The *Mastigoteuthis glaukopis* group	*Echinoteuthis* spp.
4	*Mastigoteuthis hjorti*	*Mastigopsis hjorti*
5	The *Mastigoteuthis magna* group	*Magnoteuthis* spp.
6	*Mastigoteuthis pyrodes*	*Mastigoteuthis pyrodes* (no change)

Braid *et al*. (2014) left one problem unresolved. They stated, " Unfortunately, no specimens of this species [*Mastigoteuthis pyrodes*] were examined or available for genetic analysis, and therefore, its generic placement remains unclear." In this paper we examine the generic affinities of *Mastigoteuthis pyrodes* Young, 1972 and place it in a new genus.

Materials and methods

We examined all of the specimens of *Mastigoteuthis pyrodes* at the U.S. National Museum of Natural History (USNM) and at the Santa Barbara Museum of Natural History (SBMNH). Included were the following type specimens: SBMNH 34983, holotype, ♂, ML 110 mm, and USNM 727462, 3 paratypes (2 ♂♂, ML 85 and 94 mm; 1 sex indet., ML 77 mm).

Results

We strongly support most of the conclusions reached by Braid *et al*. (2014). Our examination of *Mastigoteuthis pyrodes* indicates that this species does not belong in *Mastigoteuthis* or in any of the other genera defined by Braid *et al*. (2014). "*M*." *pyrodes* presently remains in *Mastigoteuthis* by default. On superficial examination one could easily conclude that "*M*." *pyrodes* does, indeed, belong in *Mastigoteuthis*. In fin length, fin shape and tentacle structure "*M*." *pyrodes* is most similar to members of *Mastigoteuthis*. The most compelling feature for placing "*M*." *pyrodes* in *Mastigoteuthis* (and the feature that excludes this species from all other genera in the family) is the unique presence of readily visible integumental photophores on the mantle, head and ventral arms in these taxa. A closer comparison of the integument of "*M*." *pyrodes* and the type species of *Mastigoteuthis*, however, shows that they are very different.

The photophores of *Mastigoteuthis agassizii* Verrill, 1881, the type species of the genus, appear to lie in pockets (Fig. 1). The appearance of a pocket is due to the presence of transparent, vacuole-like cells that surround the photocytes and their covering chromatophores. A photophore of "*M*." *pyrodes* appears very different from that of *M. agassizii* under the dissecting microscope. It is seen as a slight bulge in the skin,

not a pocket (i.e., without obvious vacuole-like cells), and is backed by a white reflector and covered by a dark chromatophore (Fig. 2B). Other features of the skin are also important. *Mastigoteuthis agassizii* has relatively few, scattered chromatophores in the epidermis and each is surrounded by a white ring (the thick edge of a disc that seems to extend beneath the chromatophore); this leaves most of the pigment of the skin in the dermis and not in chromatophore organs of the epidermis (Fig. 2A). In contrast, "*M*." *pyrodes* lacks these ringed chromatophores but has more numerous and densely arranged, typical chromatophores which provide most of the skin pigmentation, even though light pigmentation is present in the underlying dermis. *Mastigoteuthis agassizii* also has numerous small, spherical, white structures in the skin whose histology and function are unknown. These structures are lacking in "*M*." *pyrodes*.

These large differences in the structure of the integument, by themselves, are enough to conclude that "*M*." *pyrodes* is not a *Mastigoteuthis*. "*M*." *pyrodes*, however, also differs from species of *Mastigoteuthis* in the distribution of the photophores: both taxa have photophores on the ventral surfaces of the mantle, head and ventral arms, but only in "*M*." *pyrodes* are photophores also present on the ventral sides of the fins and the dorsal surfaces of the head and mantle. Moreover, the eyelid photophore in "*M*." *pyrodes* is much larger than its integumental photophores, while in *Mastigoteuthis* species the eyelid and integumental photophores are approximately the same size. One other major difference in these taxa is important in the derivation of the new generic name: the funnel component of the funnel/mantle locking apparatus. In "*M*." *pyrodes* this structure has a large tragus but is without an antitragus and without a posterior undercut shelf; these latter two features are always present in *Mastigoteuthis* species, although weakly expressed in some.

Because of these large morphological differences between "*M*." *pyrodes* and true species of *Mastigoteuthis*, we place "*Mastigoteuthis*" *pyrodes* as the sole species in a new genus, *Mastigotragus*.

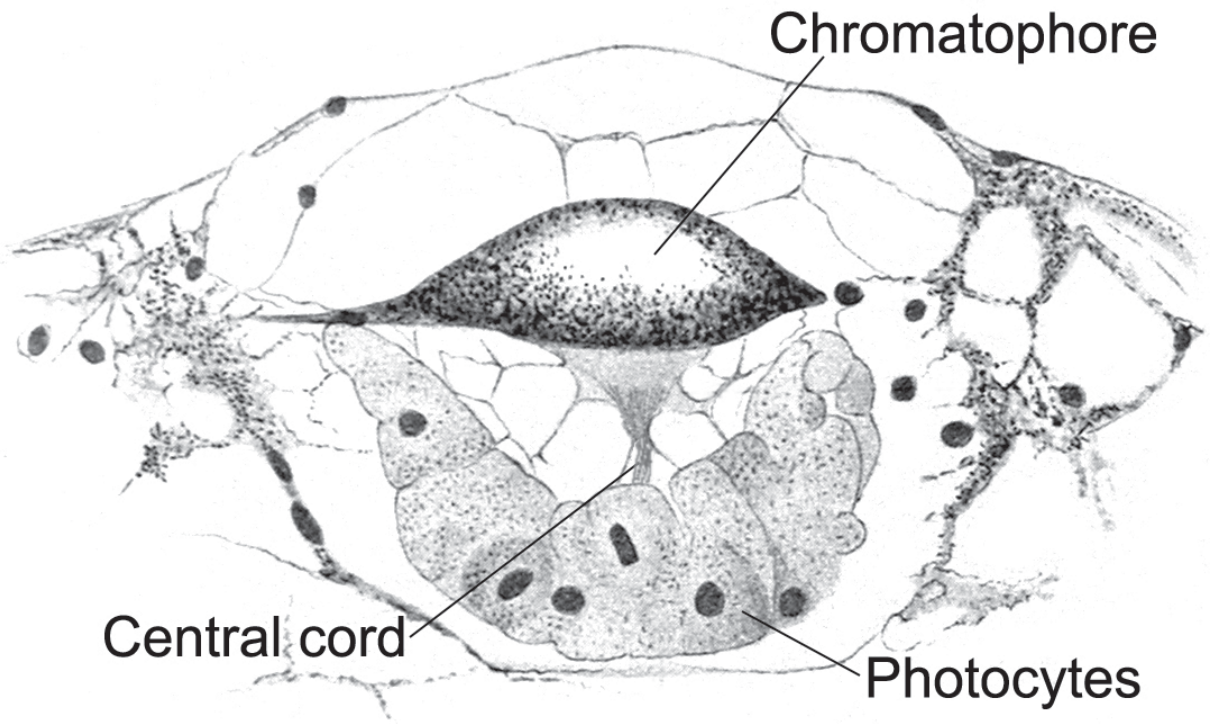

Fig. 1. Longitudinal section through an integumental photophore of *Mastigoteuthis agassizii* Verrill, 1881 (modified from Chun 1910).

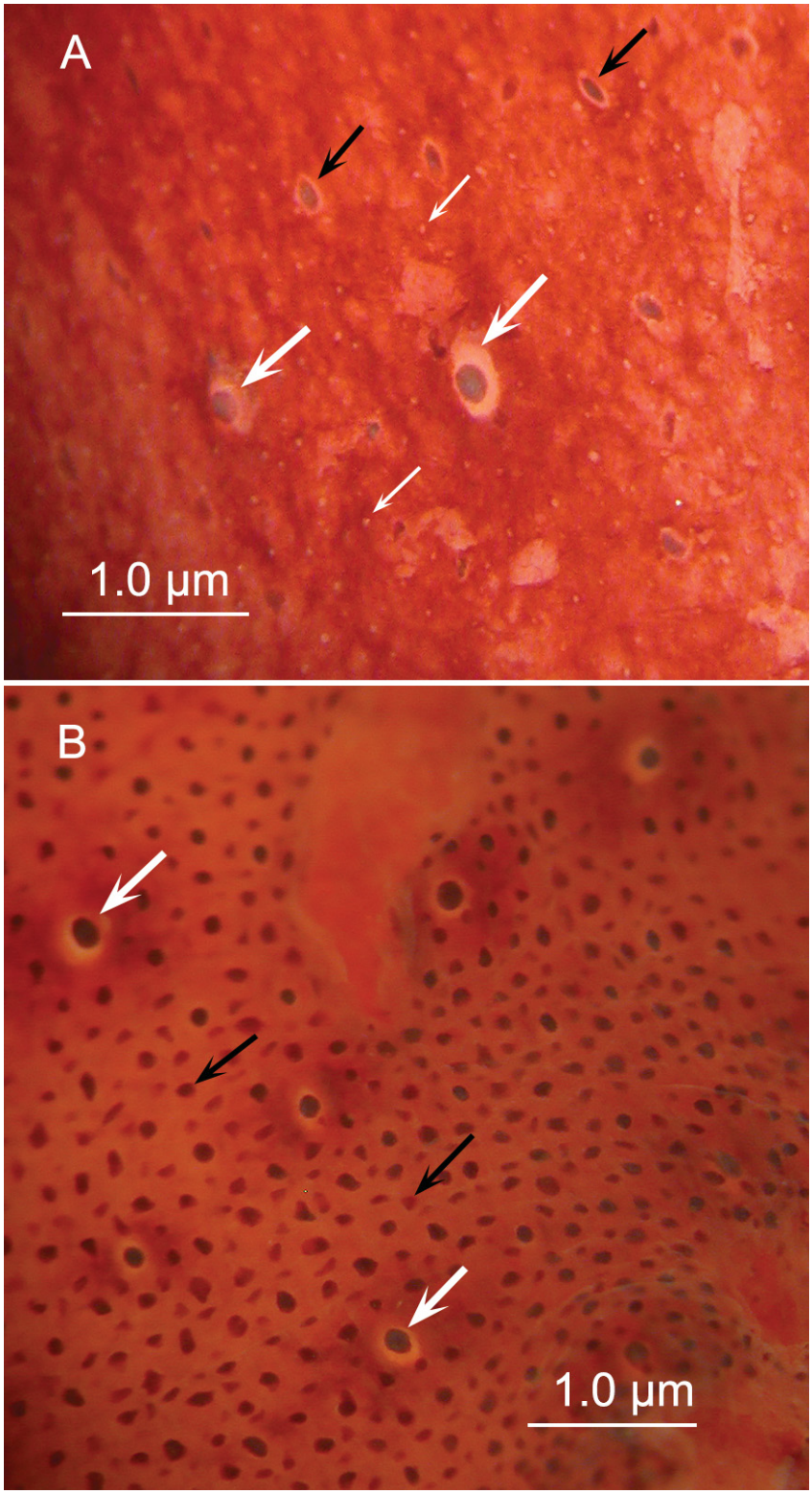

Fig. 2. Photomicrographs of the slightly damaged integument of the head (modified from Vecchione *et al*. 2004–2014). **A**. *Mastigoteuthis agassizii*. **B**. "*Mastigoteuthis*" *pyrodes* [= *Mastigotragus pyrodes*]. – Large, white arrows indicate photophores; only two photophores are visible in A but seven are visible in B. Small, white arrows indicate two of the many "white spherical structures." Black arrows indicate ringed chromatophores in A and typical chromatophores in B.

Systematics

Class Cephalopoda Cuvier, 1795
Subclass Coleoidea Bather, 1888
Order Oegopsida d'Orbigny, 1845
Family Mastigoteuthidae Verrill, 1881

Mastigotragus gen. nov.
urn:lsid:zoobank.org:act:5F1DDC20-A391-4B52-BA8A-23FFC9F7888D

Type species: *Mastigoteuthis pyrodes* Young, 1972, by monotypy.

Diagnosis

A mastigoteuthid with (1) numerous small, but easily observed integumental photophores on the ventral surface of arms IV, on the dorsal and ventral surfaces of the head, mantle and fins, and with a relatively large photophore on each eyelid; (2) a broad funnel component of the funnel/mantle locking apparatus, with strong tragus, but without antitragus or undercut posterior margin; (3) comparatively large club suckers (about 0.3 mm in diameter).

Etymology

Here "mastigo" refers to the name of the family and "tragus" refers to the prominent tragus of the funnel locking apparatus. Mastigo is Latin for "whip" which refers to the form of the tentacle; "tragus" is a Latin word derived from the Greek trágos, indicating an appearance similar to the tragus of the human ear.

Discussion

No additional histological information is available on the structure of the integument of these taxa, but the position of *Mastigotragus pyrodes* as a separate genus is well supported by morphology. We hope that, before long, fresh specimens will be captured that will enable determination of the genetic relationships of this taxon within the family. The species is known only from the eastern North Pacific, mostly off Southern Calfornia. Additional information and illustrations of the diagnostic features of *Mastigotragus pyrodes* are presented on the species page of the Tree of Life website (Vecchione *et al*. 2004–2014).

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