

## EVIDENCE DOSSIER EXERCISE 1 – Giant Squid

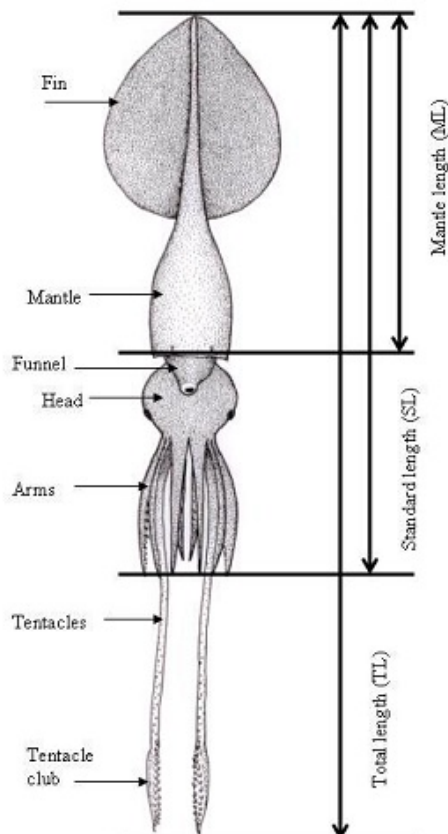
### 1. Context

There is considerable controversy as to how large giant squid get, with eyewitness reports suggesting considerably longer specimens than is the consensus within the scientific community. Based on statistical grounds, a recent paper (see information 4 below) has suggested that squid grow longer than the scientific community believes. This has ignited a debate. As a result, we are interested in the following question: how long can giant squid get?

### 2. The Parameter of Interest

Giant squid (*Architeuthis dux*) are a marine species found all over the world except at high latitudes (i.e. they are not found in circumpolar seas). Squid length is measured in three ways: mantle length (ML), i.e. the length of the body (not including the head and arms), standard length (SL), i.e. the length of the mantle plus the head and to the end of the 8 short arms, and total length (TL), i.e. the length of the mantle plus the head to the end of the 2 tentacles. (N.B. the image below is of a different species of squid than *Architeuthis*.)

Figure 1. Basic squid morphology and terminology (O’Shea and Bolstad 2008)



The parameter of interest is defined to be the longest total length (TL) amongst all *Architeuthis dux* currently alive.

### 3. Scientific opinion

Controversy arises because:

1. we cannot sample all squids
2. the arms and tentacles may stretch or shrink post-mortem.
3. many estimates are by eye and anecdotal.
4. sometimes carcasses are not intact; arms and tentacles may be missing.
5. some of the claimed measured lengths may be unreliable for reasons other than the state of the carcass.

In addition to these questions of data quality, opinion is divided over what can be inferred from the data. Below are some contrasting opinions.

#### *An online source*

A discussion of squid lengths is given in O'Shea and Bolstad (2008) 'Giant Squid and Colossal Squid Fact Sheet'. This web document contains the following opinion.

*Architeuthis* is frequently misreported to attain a total length of 20 metres (~65 feet). However, the largest specimen known washed ashore on a New Zealand beach, Lyall Bay (Wellington) in the winter of 1887. It was a female and "in all ways smaller than any of the hitherto-described New Zealand species", according to Kirk (1887), the gentleman who described this very specimen. Apparently it measured 55 feet 2 inches in total length (16.8m), but this simply cannot be correct, and this length almost certainly is a product of imagination or lengthening (stretching like rubber bands) of the very slight tentacular arms, as its mantle was only 71 inches long (1.8m). We know that it was not measured with a conventional tape, but was paced, as Kirk says so in his publication. A comparable-sized female (ML 1.8m) measured post mortem and relaxed (by modern standards) today would have a total length of ~32 feet (9.8m).

Mantle length (as opposed to total length) is the standard measure in cephalopods. Of more than 130 *Architeuthis* specimens that the authors have examined, none has attained a mantle exceeding 2.25m (7.4 feet), or total length of 13m (42 feet).

Standard Length (SL) is the length of a squid excluding the tentacles; in *Architeuthis* this measure very rarely exceeds 5m. The rest of the animal's length, to a total length of 13m, is made up of the two long tentacles. Of more than 130 specimens that we have examined, none has exceeded these figures.

*Architeuthis* beaks recovered from the stomachs of sperm whales are smaller than or of comparable size to *Architeuthis* beaks recovered from specimens trawled in New Zealand waters. Therefore, since we believe sperm whales capable of catching even the largest giant squid, no evidence exists for recognising larger specimens than those that are currently known. Moreover, it is most likely that a single species, *Architeuthis dux*, exists worldwide, so 'larger species' of *Architeuthis* do not occur.

Accordingly, to perpetuate myths of *Architeuthis* to 20 metre lengths (60 feet) and weights of up to 1000kg (a ton, or 2205lbs) is a disservice to science.

### *A journal article*

A further discussion of squid length can be found in a paragraph from McLain et al (2015).

A substantial amount of size data exists for *A. dux*, including 75 total length measurements, 167 mantle lengths, and 95 mass measurements. The maximum reported length (mantle plus tentacles) of *A. dux* is 17.37m (Verrill, 1879). The same paper describes three specimens at near 15m, and several more ranging from 12m upward and are the largest reported sizes for *A. dux*. A specimen documented in 2002 was reported to be approximately 15m, but the length was estimated and the actual tentacles were absent. The largest recorded and well-preserved specimen in the contemporary, peer-reviewed literature is 12m (Bustamante et al., 2008). Given that the few lengths >12m were not first-hand measurements and come from reported statements, we feel that the longest scientifically verified giant squid is 12m.

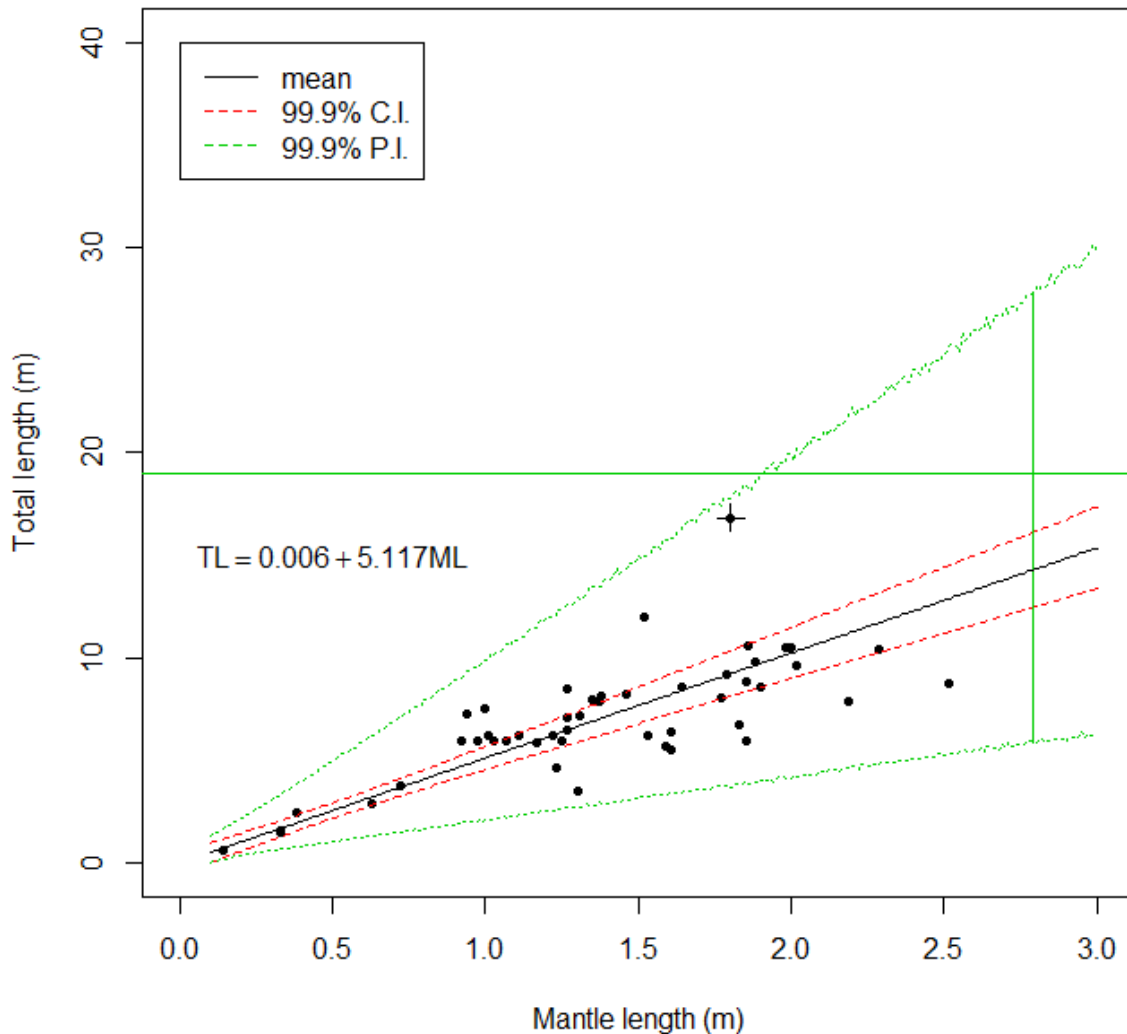
### *A recent analysis*

A recent paper (Paxton 2016) reports a statistical analysis of *Architeuthis* length data. His regression analysis produced Figure 2, below, and the author's discussion of his results includes the following.

It is possible that much of the width of the prediction interval, in the case of the TL on ML regression, is due to a lack of large specimens and, of course, there is a small amount of extrapolation. Nevertheless, given that giant squid can reach MLs of 2.79 m (Table 1) and the estimated prediction intervals, squid with a conservative TL of 20 m would seem likely based on current data. This is with no correction for elasticity except for the omission of the suspect 1887 specimen. It would be useful to determine the limits of such elasticity in *Architeuthis* to constrain these estimates and determine if the 1887 specimen really was stretched. However, if elasticity was a general consequence of stranding, for example, this ought to be detectable in the data and this does not appear to be the case and there is at least one claim of post-mortem shrinkage of tentacles (Murray, 1874).

O'Shea & Bolstad (2008) stated that of the 130 *Architeuthis* specimens they encountered, none exceeded 2.25 m ML and 13 m TL, but assuming a population of hundreds of thousands (from Roper & Shea, 2013), there are plenty of opportunities for animals to reach longer lengths and the conservative statistics strongly suggest this. I would argue that *Architeuthis* slightly larger than those proposed by O'Shea and Bolstad are probable and such a claim is not such a 'disservice to science' as they suggest.

**Figure 2.** Relationship of total length to mantle length in *Architeuthis*. Mean – best fit line. C.I. – confidence interval. P.I. – prediction interval. The total explained deviance was 77%. The horizontal green line indicates Berzin’s 19m TL claim from the Indian Ocean. The cross indicates values taken from the exceptionally long tentacled specimen found stranded in Lyall Bay, North Island, New Zealand, in 1887. The 99.9% prediction interval for the longest (2.79 m) mantle length measured (without entire length) is given by the vertical green line.



NB. The following caveats should be noted.

- In view of the quality issues with giant squid length data listed earlier, the conclusions may be sensitive to the method used to select data for the statistical analysis.
- The vertical green line is an extrapolation that may be sensitive to any departure from the assumptions made in the statistical analysis (a generalized linear model with gamma error structure and identity link).

#### 4. Data

The following is a collection of extreme lengths derived from various sources.

##### *Wikipedia*

The four largest total length measurements in a list of giant squid specimens found at Wikipedia. [https://en.wikipedia.org/wiki/List\\_of\\_giant\\_squid\\_specimens\\_and\\_sightings](https://en.wikipedia.org/wiki/List_of_giant_squid_specimens_and_sightings)

<b>Total length (m)</b>	16.0 (Verrill 1874), 16.81 (Pfeffer 1912), 19.0 (Berzin 1972), 21.95 (Kilias 1993)
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##### *O'Shea and Bolstad*

The web article O'Shea and Bolstad (2008) cited above gives the following maxima, repeated here for convenience.

<b>Total length (m)</b>	13 (O'Shea and Bolstad 2008)
<b>Mantle length (m)</b>	2.25 (O'Shea and Bolstad 2008)

##### *McLain et al*

The following are the figures cited above from McLain et al (2015), repeated here for convenience.

<b>Total length (m)</b>	17.37 (Verrill, 1879), 12 (Bustamante et al., 2008)
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##### *Paxton*

In the recent article, Paxton (2016), the following table is given

	<b>Mantle length (m)</b>	<b>Standard length (m)</b>	<b>Total length (m)</b>
<b>Longest measured</b>	3.4 (Dell 1952 , Förch 1998) More reliably 2.8 (Kirk 1880)	9.5 (Verrill 1879)	19.0 (Berzin 1972) 16.8 (Kirk 1888) 16.8 (Verrill 1879)
<b>Longest estimated by eye</b>	c. 30.0 (Lipington pers. comm.) 4.0 (Lynch 2014)	c. 53.3 (Starkey 1963 ) c. 30.5 (Braun, undated)	c. 18.3 (Murray 1874)

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