

## LETTER TO THE EDITORS

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Dear Editors,

MR. A. K. TOTTEN had for several years been studying the nematocysts of siphonophores, especially the Mediterranean species, with a view to producing a review article. However, his death on 12 January 1973, preceded by many illnesses has prevented the completion of this task and so I have taken the liberty of abstracting for publication an account of his method for discharging nematocysts. Mr. Totton wrote an account of this method after his visit to Villefranche-sur-Mer in 1967.

Mr. Totton's collection of named siphonophores, copious notes, manuscript papers and reprints has been presented to the British Museum (Natural History) by his son. A bibliography of Mr. Totton's published papers has been compiled, with the assistance of Dr. P. F. S. Cornelius, and is included here. His notes and manuscripts included amongst them a review of the available knowledge of *Gerardia savaglia* Rossi (Zoanthinaria) with a new record from Gibraltar; an account of the hydroid and young medusa of *Pachycordyle* Weissmann (Hydrozoan); and some brief notes on the phylogeny of the Anthozoa in which the stauromedusan radial canal walls are proposed as the origins of the Anthozoan septa. However, his most important uncompleted work probably is that which is concerned with the origin and function of the bracts in siphonophores. This manuscript discusses the medusoid or polypoid origin of the bracts from the various families. The physonect bracts, such as those of *Nanomia bijuga*, arise from the stem, as do the palpons and gastrozooid and are thus polypoid in origin. However, a medusoid origin is proposed for the bracts of the Diphyidae and Abylidiae as the gonophores and the phyllocyst of the eudoxid bract were shown by Totton to be budded from the pedicel of the gastrozooid in *Chelophyses appendiculata*. More recent and laborious work with specimens of *Praya dubia* led Mr. Totton to conclude that the origin of the Prayidae bracts was also medusoid, as similarly they were budded off amongst the gonophores from the pedicels of the gastrozooids. He also drew attention to the basic plan of the four bracteal canals in the Prayidae which is reminiscent of the radial canals of Hydromedusae.

An obituary of Mr. Arthur Knyvett Totton appeared in *Nature*, London 244, 187-188, 1973.

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## A method for discharging nematocysts

by the late A. K. TOTTON

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"The study of nematocysts seems clearly to be in its infancy" (Cadet Hand, in: LENHOFF and LOOMIS, 1961)

PICKEN AND SKAER'S (1966) 'A review of researches on nematocysts' with its long list of references was limited for the most part to the developments reported since 1953. As they stated, an extensive survey of the earlier literature will be found in the monumental work of WEILL (1934), and access to more recent literature is given in *The biology of Hydra* (LENHOFF and LOOMIS, 1961). They also pointed out that for the proper evaluation of the taxonomic importance of nematocysts further electron-microscope studies are essential. In addition, they reminded readers that CUTRESS (1955) emphasized the practical difficulties in determining minute details of structure in the light microscope and the many errors springing therefrom. They also summarized and commented on the terminology and classification of nematocysts contained in a subsequent paper by WERNER (1965). Nevertheless, we have only made a beginning of a survey and record of the macrostructure of the vast numbers of Cnidaria. Of the 150 species of Siphonophora in particular, in which group we find the greatest variety of structure and distribution of these organelles, the macrostructure of only 15–20% has been recorded. WEILL (1934) was the last major reviewer of the types of nematocysts found in siphonophores, but we are indebted to the numerous papers by Danielle and Claude Carré in continuing these studies. I personally have been able to study in detail the nematocysts of *Apolemia uvaria*, *Agalma elegans*, *Halistemma rubrum*, *Nanomia bijuga*, *Forskalia edwardsi*, *Rosacea cymbiformis*, *Hippopodius hippocampus*, *Lensia subtilis*, *Muggiaeae kochi*, *Chelophyses appendiculata*, *Sphaeronectes* spp. and *Abylopsis tetragona*. The completion of this survey is a matter of great importance for systematists and it is hoped that the simple and rapid method described below for making preparations of discharged nematocysts will enable workers in the field everywhere to hasten the completion of a survey of all Cnidaria.

During several visits to the Station Zoologique, Villefranche-sur-Mer, France, I have made numerous attempts to produce satisfactory preparations of the discharged nematocysts of siphonophores. I have to thank the Sous-Directeur M. P. Bougis and his predecessor Prof. G. Tregouboff for having given me all possible aid and facilities there. In 1967 I was able to experiment with electric shocks from a small transformer through the kindness of Prof. R. Weill, and with saponin, acetic acid, neutral red, distilled water, tap water, pressure and manipulation with fine needles. However, with all these methods I achieved only partial success.

My colleague Dr. G. O. Evans had suggested to me at that time that I use gum chloral as a mountant for these preparations as he had been using it to mount acarines. When I tried adding this directly to a siphonophore tentillum on a microscope slide, I found to my surprise on examining the nematocysts that almost all of them had been discharged. Since gum chloral also has the right refractive index for photography of nematocysts using phase contrast microscopy, it is ideal for the purpose.

On the basis of this discovery, I thus adopted the following method for the preparation of slides of discharged siphonophore nematocysts. A recently caught speci-

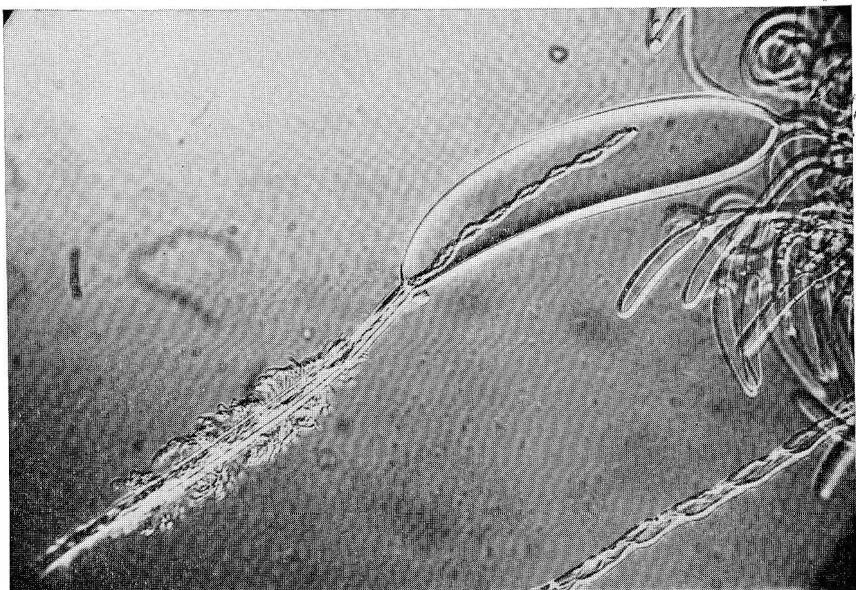


FIG. 1. Discharged mastigophore from the *bouton urticant* of *Vogtia spinosa* Kefferstein and Ehlers, 1861.

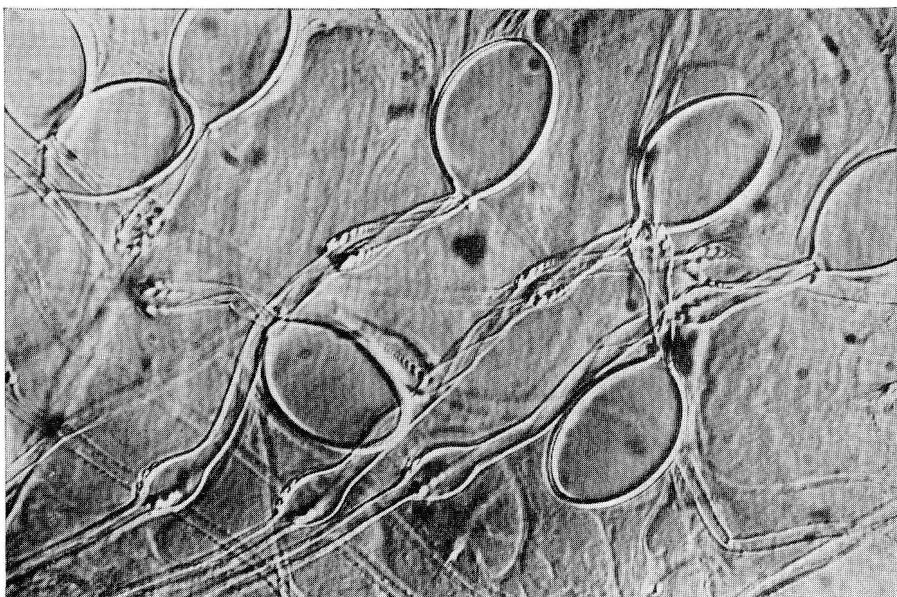


FIG. 2. Discharged birhopaloides from a *palpacle* of *Apolemia uvaria* (Lesueur, ?1811).

men was placed in a 1 : 1 seawater-isotonic magnesium chloride solution until the tentacles were relaxed. These were transferred on to microscope slides and the surplus water drained off without disturbing the tentilla. A few drops of gum chloral were added and the preparation covered with a cover slip. Using this method I have found that *boutons* could be activated and nematocysts discharged even after anaesthetizing as described for 12 hours or more. In general, however, this procedure allows one to make preparations of nematocysts very easily and quickly and could be employed aboard deep-sea research vessels, especially in the cases of specimens which usually reach the specialist only after fixation in formalin. M. C. Carré has kindly supplied the photographs which I use here to illustrate the effectiveness of gum chloral for discharging nematocysts (Figs. 1 and 2).

Since the material used is fresh it will soon deteriorate under normal circumstances and so photography should, if practicable, be carried out as soon as possible. However, Dr. P. R. Pugh has informed me that he made some nematocyst preparations using this technique during a cruise on R.R.S. *Discovery* and, by deep-freezing them, found that they were still in good enough condition for photography even after several months.

Gum chloral is available in England either as Berlese's fluid, with 75% chloral hydrate, or as Faure's fluid with 50% chloral hydrate. It is the chloral hydrate which appears to be the main activating substance, as M. C. Carré (personal communication) informs me that he obtains good results when simply using a 50% solution of it. Although I myself have only used gum chloral to discharge the nematocysts of siphonophores, several other workers to whom I have communicated the technique have used it successfully with other cnidarian preparations.

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