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SPECIAL ISSUE

Chironex fleckeri & Chiropsalmus quadrigatus — Morphological Distinctions.

By J. H. BARNES.

"THE AUTHOR IS RESPONSIBLE FOR THE OPINIONS AND FACTS EXPRESSED IN THIS ARTICLE."

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Chironex fleckeri & Chiropsalmus quadrigatus — Morphological Distinctions.

By J. H. BARNES, 56 Abbott Street, CAIRNS.

In summer months, the coastal population of northern Australia has a stinger problem. From Broome in the west to Gladstone on the east, tropical inshore waters are at times heavily infested with jellyfish, representing some hundreds of different species. While the vast majority of these are quite harmless to humans, twenty or more species are known to cause mild and transient skin irritations, a few raise painful weals, one (the "Irukandji" carybdeid) causes a very unpleasant short-term illness, and only the large multi-tentaculate Cubomedusae (variously called "box-jellies", "cubos", or "sea-wasps") are currently accepted as potentially lethal stingers.

Deaths due to marine stings are not numerous, averaging less than three per annum for the whole Australian coastline, but there is a special quality about these deaths which has demoralised a large section of the bathing public.

Community reaction to "stinger deaths" is out of all proportion to their frequency, and it is indeed remarkable and alarming that, in their fear of marine stings, many people are now turning to rivers and freshwater pools, where the risk (and actual incidence) of drowning exceeds all combined hazards likely to be encountered at an efficiently patrolled beach.

There is then an urgent need for unemotional review of relative risks, taking full advantage of existing knowledge, and seeking further information by appropriate investigation. Such investigation must concern itself primarily with the Cubomedusae, for in Australian waters these are apparently the only jellies which threaten life, or regularly produce severe injury or illness.

A recent publication, "Cause and Effect in Irukandji Stingings" (Barnes, Medical Journal of Australia, June 13, 1964) describes in detail the conditions under which Irukandji stings occur, and outlines effective medical treatment. Our major efforts are now directed against the large "box-jellies", **Chironex fleckeri** and **Chiropsalmus quadrigatus.**

Although these two jellyfish are very similar in appearance, and appear during the same season, they differ very widely in distribution, behaviour, and stinging potential. Because of these important differences it is not possible to make accurate predictions, prescribe correct treatment, or collect specific venom, until reliable identifications have been established. And obviously, to be of maximum value, such identifications must be made on the spot, without waiting for the services of an expert.

Fortunately, because we are dealing with only two common species, any obvious differences between these two can be used for what might be called "spot diagnosis". The occasional errors which may arise in these provisional identifications will be less important than the many advantages to be obtained.

I propose therefore to describe certain structural (morphological) distinctions between **C. fleckeri** and **C. quadrigatus**, to be used for these practical purposes. As most serious workers will wish to check their "spot diagnoses", this article also carries an addendum on handling, preservation, and labelling of material for study under less urgent circumstances.

Basic Anatomy.

Both **C. fleckeri** and **C. quadrigatus** (and indeed all Cubomedusae) are constructed on the same general pattern. The body is more or less bell-shaped, with a hollow interior, but in contrast with most other jellyfish, the general shape is not round but rather square, as in the following diagrams.

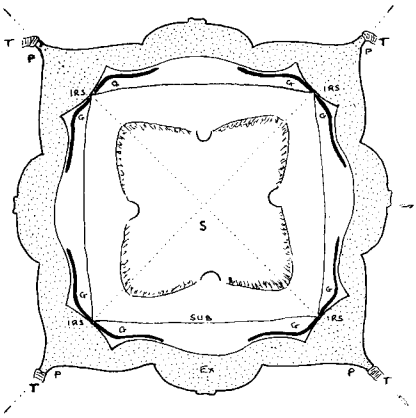


FIG. 1.

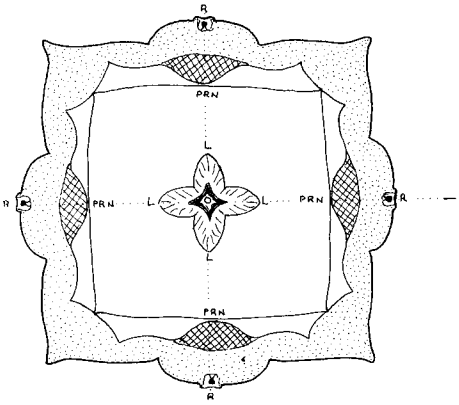


FIG. 2.

Plan drawings of the major anatomical features of **C. fleckeri** and **C. quadrigatus**, showing their relationship to the interradii and perradii. Both diagrams apply equally to either species. In actual cross-sections, the various organs would appear at different levels.

Figure 1. Interradial lines pass through the pedalia and the uppermost (unpaired) tentacles, also the interradial septa, and the corners of the stomach cavity.

Figure 2. Perradial lines pass through the rhopalia, perradial nuclei (shown cross-hatched), and the lips of the oesophagus.

Ex (shown in stipple) — exumbrella, the fleshy outer layer; Sub — subumbrella, the membranous inner layer; G (heavy lines) — gonad; IRS — interradial septum; L — lips of oesophagus; O — oesophagus; P — pedalium; PRN (hatched area) — perradial nucleus; R — rhopalium; S — stomach; T — tentacle.

Note that in figure 1, lines have been drawn diagonally, joining opposite corners. These lines are the interradii. Along the interradii lie the pedalia, those fleshy projections variously referred to as "arms", "legs" and "hands", to the branches of which the tentacles are attached. Also in the interradii are the interradial septa, formed by the fusion of the internal and external layers of the jellyfish at this point. This junction line extends vertically from the level of the pedalia to the level of the stomach and, as will be seen later, gives rise to the reproductive tissues or gonads.

The stomach is a flattened space in the top end of the jellyfish, outlined by a whitish fringe of digestive filaments. From the centre of the stomach the swallowing-tube, or oesophagus, hangs down within the cavity of the bell, ending in four petal-like expansions, representing the mouth and lips.

In figure 2 another pair of lines have been drawn, this time joining the mid-points of the opposite sides. These lines are the perradii. The most obvious structures in the perradii are the four sensory organs (rhopalia), which are the small black "eyes" part hidden inside a niche in the side wall of the jelly.

Differentiating Features.

Although four species of multi-tentacled Cubomedusae ("box-jellyfish") have been recorded from the Australian coastline, two of these, **Chiropsalmus buitendijki**, and **Chiropsalmus quadrumanus** apparently do not frequent inshore waters, or if they do their numbers must be comparatively small. I have never seen an example of these rarities, and, as far as I know, neither has been reported in recent years.

For practical purposes, then, **C. buitendijki** and **C. quadrumanus** can be ignored, and it is necessary to distinguish only between the two common species, **C. quadrigatus** and **C. fleckeri.**

Pedalial canals.

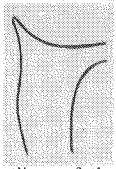
The first, easiest, and certainly the most constant difference between **C. quadrigatus** and **C. fleckeri** lies in the shape of their pedalial canals. In both

species the pedalial canal is a tubular channel passing through the transparent fleshy pedalium, carrying nutriments from the jellyfish to its tentacles. The lining membrane of the canal is whitish and partly opaque so that its outline is readily visible, especially against a bright background.

At all sizes, in both sexes, and irrespective of other changes, the pedalial canal of **C. fleckeri** shows, in its first or proximal third, a marked expansion which extends upward in the shape of a rose-thorn (see Fig. 3, also Figs. 5 and 14.) This triangular expansion of pedalial canal, which has been called the corniculum (meaning "little horn"), is not peculiar to **Chironex,** occurring in other Cubomedusae, but it is never present in specimens of **C. quadrigatus,** at any stage.

In **C. quadrigatus** the pedalial canal has a fairly uniform bore in its horizontal course, and then bends sharply downward towards the tentacles. Its outline (Fig. 4, also Figs. 6 and 10) could be likened to an elbow or a knee. The angle of the bend is approximately one hundred degrees, but varies slightly depending upon the state of contraction or relaxation of the pedalium. Occasionally **C. quadrigatus** will show a small knob or "pimple" at the end of the first part of the pedalial canal, but this small protrusion is unlikely to be confused with the upswept corniculum of **Chironex.**

FIG. 3.
C. fleckeri.



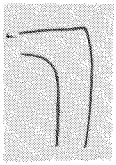
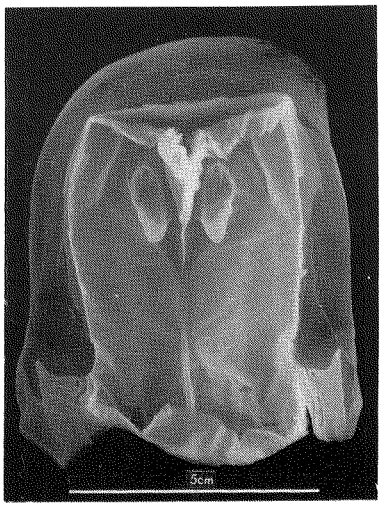


FIG. 4.
C. quadrigatus.

Comparision of outlines of the proximal portions of the pedalial canals of **C. fleckeri** and **C. quadrigatus.**



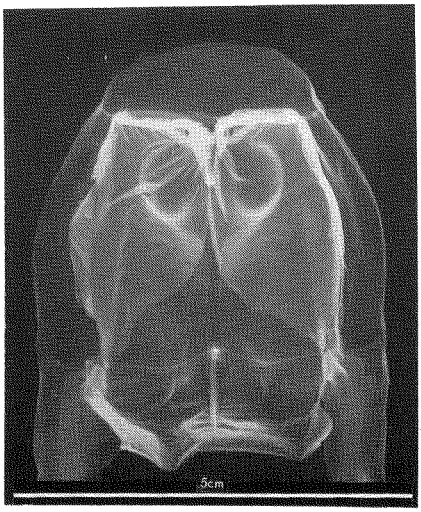


FIG. 5. FIG. 6.

In Figures 5 and 6, the jellyfish has been sliced vertically, removing all except one "wall", which has been photographed from the inner (subumbrella) aspect.

Figure 5 shows the early differentiation of the perradial nucleus of **C. fleckeri,** forming vertical ridges with undulating free margins. Gonad can be seen as whitish tissue arising from the upper part of the interradial septum, and moving towards the perradial nucleus. Note the distinctive corniculum on the pedalial canal of **C. fleckeri.**

Figure 6. The developing perradial nucleus of **C. quadrigatus** forms twin rounded bulges. Gonad is shown arising from the full length of the interradial septum, covering the perradial nucleus, and meeting its neighbour in the perradial line. Note the "knee" which is typical of the pedalial canal of **C. quadrigatus.**

Perradial Nucleus and its Processes.

In the perradius (refer if necessary to Figure 2), just below the level of the stomach, and well above the rhopalar niche, both **C. fleckeri** and **C. quadrigatus** have a thickening in their side walls, protruding inward; and this mesogloeal condensation, which I call the perradial nucleus, grows more rapidly than the other tissues of the jellyfish. Consequently, in larger specimens, it comes to form an expanding intrusion into the cavity of the bell, where it develops special shapes characteristic of the species.

In very small specimens of both **C. fleckeri** and **C. quadrigatus** (three tentacles or less on each pedalium), the perradial nucleus is of little assistance, being merely a heart-shaped mound of clear tissue. In slightly larger specimens, it rises as twin humps on either side of the perradius, and, by the time the jellies have acquired five tentacles on each pedalium, minor differences are detectable. These become very obvious as further growth occurs.

In **Chironex** at the four or five tentacle stage, conical pimple-like papillae appear on the convexity of the paired perradial bulges (Fig. 11B), and soon unite into a more or less vertical ridge, with an undulating crest (Fig. 5). With further growth, this primary ridge fans out like a coxcomb (Fig. 11C) then folds upon itself to form a whorl (Fig. 7). Later again the free margin proliferates, budding off an arborising series of stubby digitations which, in fully mature specimens, occupy most of the available space within the bell. (The extent of the perradial nucleus in large specimens is indicated by the dotted area in Fig. 11C).

In **C. quadrigatus** on the other hand, the enlarging perradial swellings show no such elaborate development. Retaining their smooth unbroken convexity and circular cross-section (Fig. 6), they simply elongate and become pendulous, like breasts without nipples (Fig. 8).

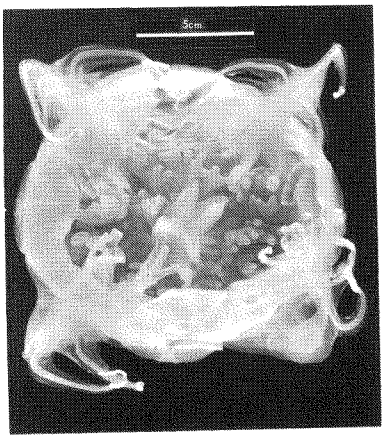


FIG. 7.

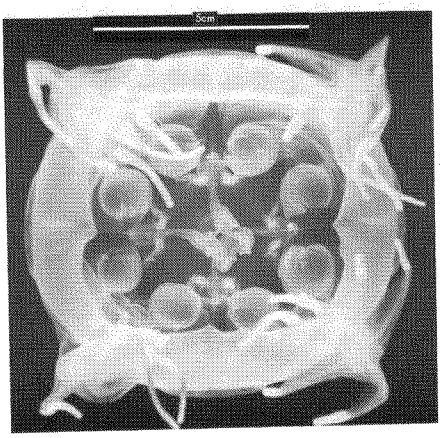


FIG. 8.

In these photos the view is upward, through the open end of the bell.

Figure 7. Chironex gonad in larger specimens ensheaths the whorls of the perradial nucleus as the latter expands from the digitations on its free margins. This specimen is about half-grown.

Figure 8. The perradial nuclei of **C. quadrigatus** form conspicuous rounded protrusions, into the cavity of the bell. Their surfaces are smooth, and covered with a single layer of gonad tissue. The specimen is nearing full maturity.

Gonads.

In both **C. fleckeri** and **C. quadrigatus**, reproductive tissue first appears at the interradii, originating from both sides of the interradial septa (this structure is illustrated in Fig. 1).

In **C. fleckeri,** only the upper half (or less) of the interradial septum produces gonad tissue, whose growth is directed towards the perradius (Figs. 11A and 11B). At about the 8 tentacle stage, a bridge of gonad tissue reaches the enlarging mound of the perradial nucleus (Fig. 11C), and thereafter all extensions and outgrowths from the latter form a core over which the **Chironex** gonad spreads, thereby achieving a very large area.

In **C. quadrigatus,** the gonad origin is larger, and lower, initially involving the centre half (Fig. 11D) of the interradial septum, then spreading upward and downward, until the full length of the septum contributes to its growth (Fig. 11F). Coincident with this widening of its "base", the **Chiropsalmus** gonad enlarges like a growing leaf, its convex border pushing towards the perradius, which it eventually reaches a little above the rhopalar level (Figs. 6, 11F, 15). The perradial nucleus of **Chiropsalmus,** with its mammiform expansions, stands in the path of the upper portion of the extending gonad, and is surmounted as in **C. fleckeri,** but this minor diversion adds little to the total reproductive area.

In practice, these gonadal differences can be very helpful in identifying small specimens, especially in the preserved state. Formalin preservation converts the barely visible gonad sheets into opaque whitish structures which stand out clearly against the semi-transparency of other tissues.

Thin parallel lines of gonad may be present in specimens of **C. quadrigatus** as early as the 3 tentacle stage, long before there is any differentiation of the perradial nucleus, and this early appearance and typical situation (Fig. 10)

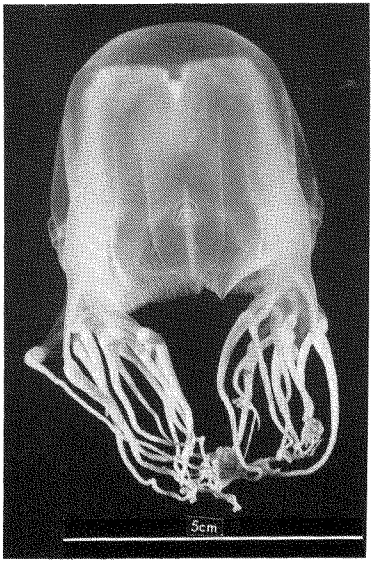


FIG. 9.

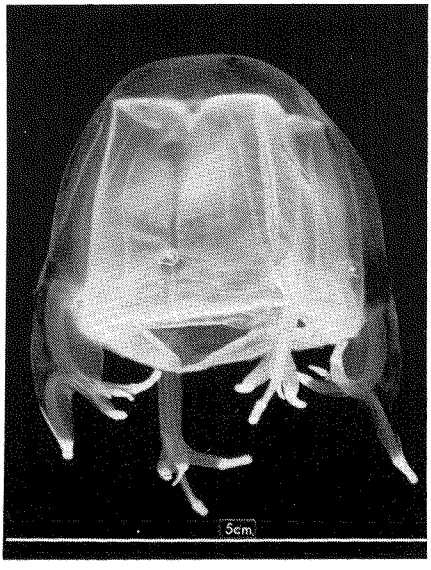


FIG. 10.

Figure 9. Small preserved specimen of **C. fleckeri,** demonstrating typical shape at this stage. Although fully contracted, the tentacles are massive and robust. This jelly has five tentacles on each pedalium. The perradial nucleus is just beginning to develop, and no gonad is visible. The rhopalar lips and niches are well demonstrated.

Figure 10. Preserved specimen of **C. quadrigatus,** at 3/4 tentacle stage. Gonad has already formed along the interradius, from stomach to pedalial levels. The peaked appearance of the foremost pedalial canal is due to camera angulation.

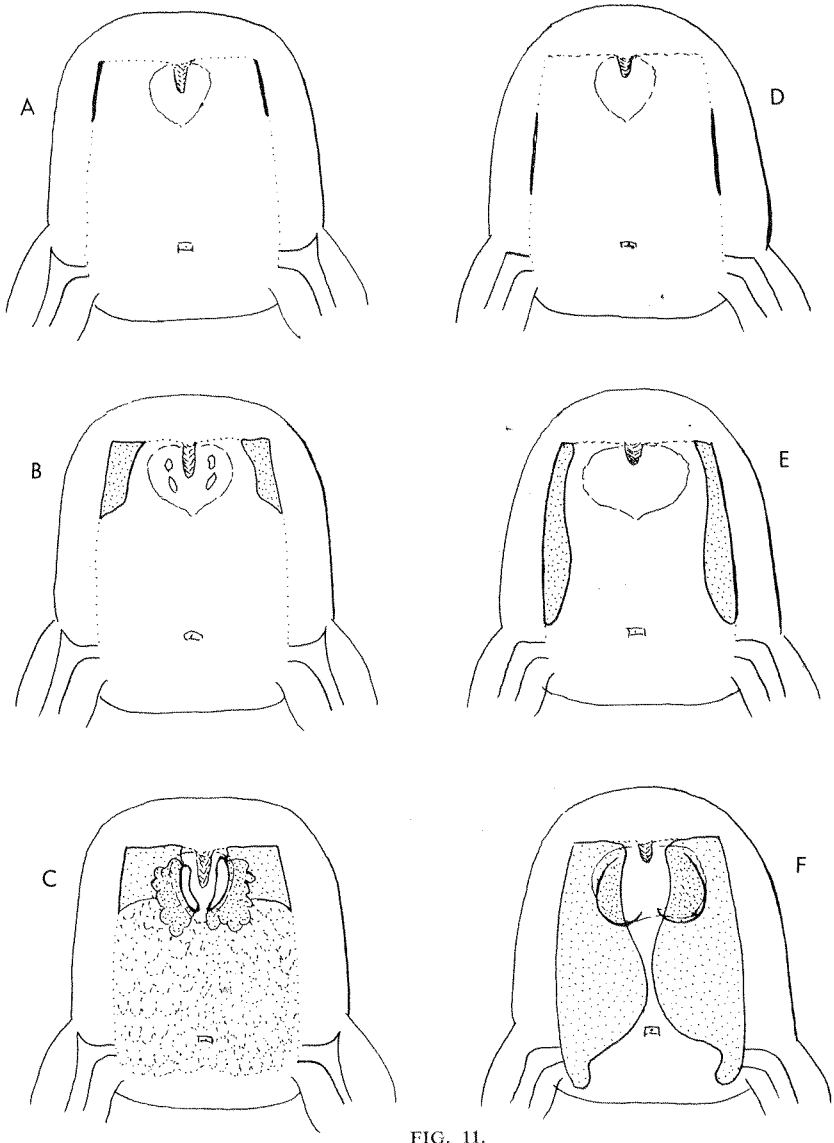


FIG. 11.

C. fleckeri. **C. quadrigatus.**

Drawings A, B, and C, on the left, show the gonad of **C. fleckeri** arising from the upper part of the interradial septum (A), moving towards the perradial nucleus (B) which is developing pimple-like outgrowths. In (C) the perradial nucleus is at the "coxcomb" stage, and covered by a single layer of gonad tissue. The dotted area in (C) indicates the final extent of the processes of the perradial nucleus at full maturity.

Drawings D, E, and F, refer to **C. quadrigatus.** Gonad first appears near the middle of the interradial septum (D), then extends in all available directions (E). The perradial nucleus enlarges, producing twin convexities which are covered by gonad as the latter moves towards the perradius (F).

of gonad is good evidence when, through rough handling, the shape of the pedalial canals may be difficult to discern.

Conversely, the absence of leaf-like gonads in medium-sized preserved specimens is reasonable presumptive evidence that the species is not **C. quadrigatus,** but probably **C. fleckeri** (compare Figs. 9 and 10).

Other Distinctions.

Sometimes, as when diving in murky waters, it is neither helpful nor wise to approach a "box-jelly" too closely. The following points can then be useful in making a tentative identification from afar :

(a) **Size of body.** If more than four inches in size, the specimen is very probably **C. fleckeri. C. quadrigatus** is the smaller species, and most specimens are under four inches in width.

(b) **Colour of tentacles.** On medium-sized jellies, if all tentacles are brightly coloured, they probably belong to **Chiropsalmus.** On healthy jellies of both species, the outermost (unpaired) tentacles are bluish or purple, and on juveniles the remaining tentacles may be quite vivid shades of yellow. In larger sizes, **C. quadrigatus** often retains its yellows, but the paired tentacles of **Chironex** soon fade to a dirty greyish-white.

(c) **Width of tentacles.** Wide ribbon-like tentacles are typical of **Chironex. Chiropsalmus** tentacles are finer, for any given size of the body (compare Figs. 12 and 13).

(d) **Number of tentacles.** If each pedalium carries more than eight tentacles, then the jelly is probably **Chironex. Chiropsalmus** in these waters very rarely, if ever, carries more than nine tentacles, even at full maturity, whereas **Chironex** at full maturity has fifteen tentacles to each pedalium.

(e) **General appearance, solidarity, speed of movement.** Under similar conditions of nutrition, **Chironex** is a more robust jelly than **Chiropsalmus,** has thicker mesogloea, and a more clearly defined cuboid shape. It swims faster, and has a more solid "feel" when handled.

Handling live Specimens.

The outside of the bodies of **C. fleckeri** and **C. quadrigatus** can be handled with impunity, provided the tentacles are kept clear. When collecting from a net, push the tentacles aside with a stick, and grasp the apex of the jelly firmly between thumb and fingers. The extra firmness of the top of the bell makes these jellies quite easy to hold. When lifting the jelly, be sure you are up-wind from the trailing tentacles.

The same principles apply when collecting in calm water — get ahead of the movement of the jelly, let the body swim into your hands, then promptly lift upwards and away from your body. Don't forget the possible effect of tide and wind on the tentacles. Protective clothing should be worn.

In rough water use a scoop net with a long handle, or better still, observe from the beach.

Tentacles retain most of their stinging power after removal from the water, and even after many months can still cause injury in the presence of adequate moisture. Formalin or spirit destroys this power.

Preservation of Specimens.

In the present phase of stinger investigations, well preserved and properly labelled specimens are welcomed by most authorities, and even should you wish to retain the specimens, there should be no difficulty in obtaining expert identification.

The best preservative for all jellyfish is "Formalin" (Formaldehyde Solution B.P.)

One volume of Formalin added to every ten volumes of sea-water (including the volume of specimens contained therein) will give good preservation, and does not cause the shrinkage and distortion inevitable with Methylated Spirits — the next best choice.

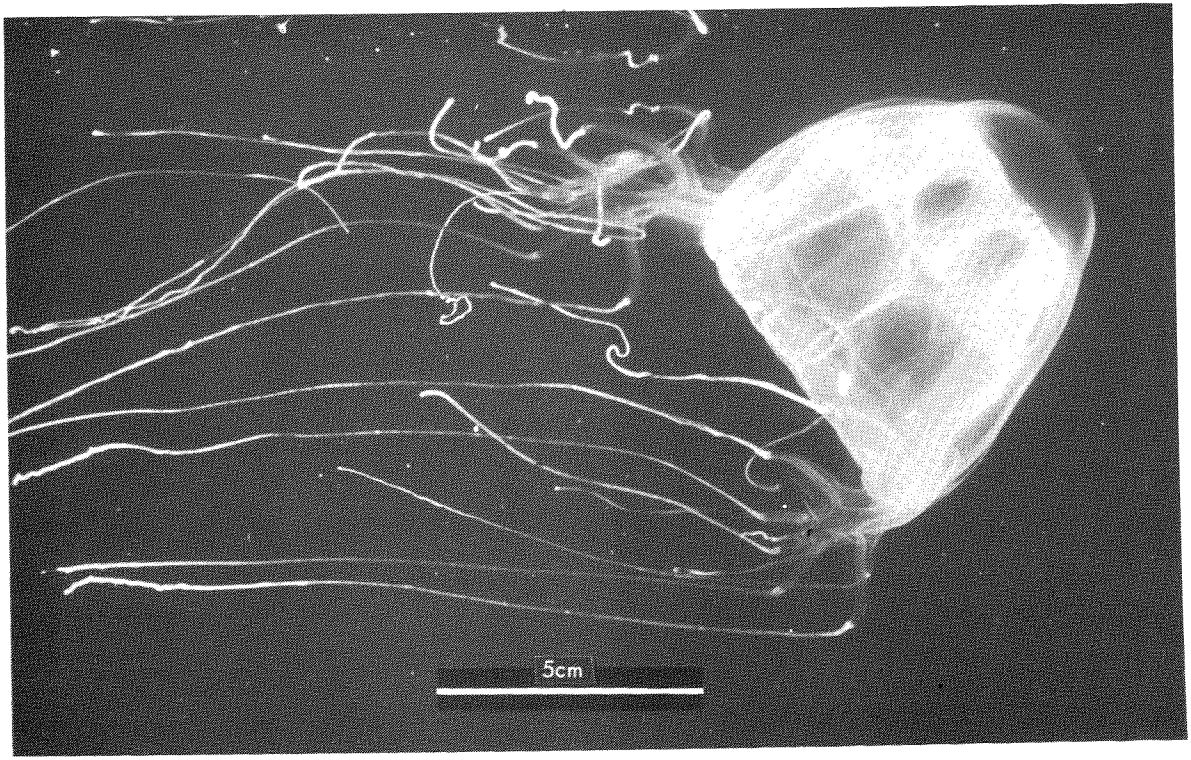


FIG. 12.

Figure 12. C. quadrigatus, swimming. Note the thin tentacles, and the two transparent oval areas (perradial nucleus) just below the level of the stomach. The high density at the interradii is due to collapse and rumpling of the gonad layer.

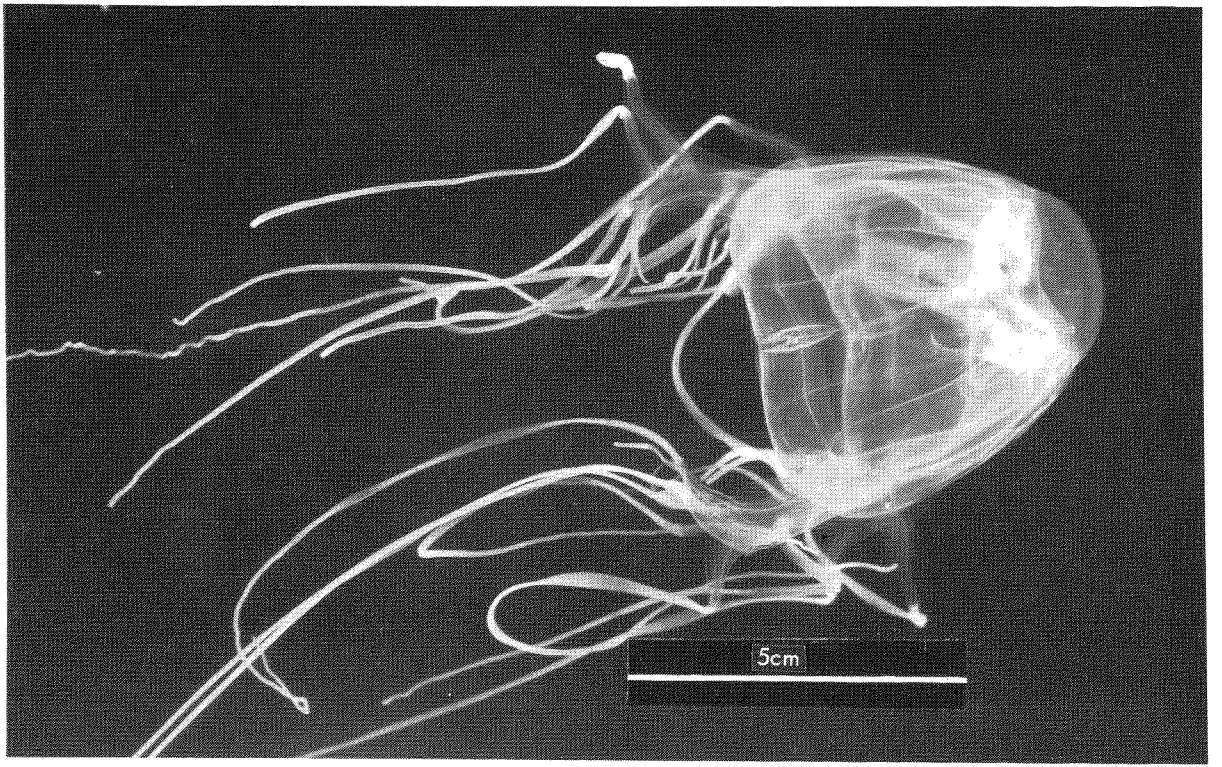


FIG. 13.

Figure 13. C. fleckeri, swimming. Note the thicker ribbon-like tentacles. The gastric filaments fringing the stomach are well demonstrated. Gonad is absent except near the upper half of the interradial septum.

The container should be of glass, plastic or other material not subject to staining or corrosion. Plastic bags are satisfactory if supported in a suitable box or carton. Plastic rubbish bins are excellent for larger specimens. To prevent distortion of the specimen the receptacle should be of sufficient size to allow free movement in all directions.

For choice specimens, have the jelly swimming, then trickle the Formalin down one side of the container. The jellyfish is killed in a natural attitude, and settles slowly into the stronger layers of Formalin near the bottom.

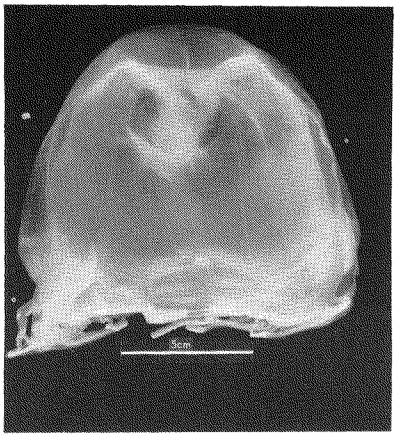


FIG. 14.

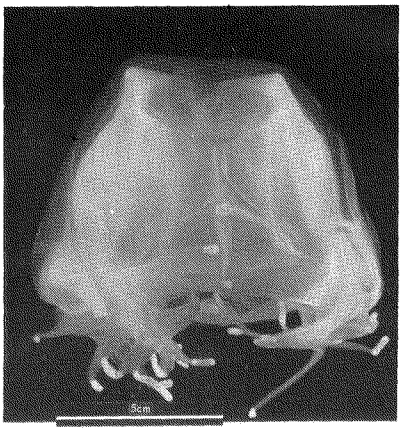


FIG. 15.

Figure 14. Fairly large **C. fleckeri,** in the typical contracted position produced by sudden preservation. Gonad is visible in both "shoulders", extending from the upper half of the interradial septum to the perradial nucleus. Note the shape of the base of the perradial nucleus, like two beans facing each other.

Figure 15. Large **C. quadrigatus,** preserved in contracted posture. Gonad leaves reach the perradius a little above the rhopalium. The base of the perradial nucleus is very wide. Tentacles have been removed from both specimens.

Labelling.

A specimen without collection data loses most of its value. Efficient labelling is simple. The essential information is "Where collected", "When collected", and "Collector's name". Other interesting details are always welcome Write with carbon pencil (not ink or biro) on good quality paper. Place this paper with the specimen, **inside the container.** Here it will not be damaged or lost, but will be preserved indefinately, probably outlasting the specimen.

Author's Note. Usage of the names **C. fleckeri** and **C. quadrigatus** herein is in conformity with other recent Australian writings. Should the minor departures from original descriptions necessitate nomenclatural adjustment, sufficient description has been provided to ensure correct interpretation.

The work here reported has been supported by grants from the Cairns Junior Chamber of Commerce, the Department of Harbours and Marine, Queensland, and the National Health and Medical Research Council, Australia.

EDITORIAL

Since our last journal, the Club has been active in various ways. In September the Club put a float in the "Fun In The Sun Procession". This was a great success and helped to draw the attention of the townsfolk to our Club and its activities. On the same day, members of the Bird Observers Club were entertained with a slide evening and social hour. The Bird Observers Club members came from all parts of Australia and were here on their Annual Bird Campout. Next day members of both Clubs made a trip to Port Douglas which was very rewarding. Others went to Michaelmas Cay but unfortunately this trip was not a great success owing to the weather which prevented them from landing on the Cay and really studying the birds there.

Entertainment at the meeting continues to be of an improved standard and in view of this it is disappointing to see so few local members taking part. The same can be said of the Field Days, much of interest is seen and learnt, but all too few members are there to benefit.

We are still looking for Finger Cherries for The Defence Standard Laboratories at Ascot Vale, Victoria. If any member can get hold of any of these fruits, please send them, plus leaves and stalks, to the above address, taking care not to rub off any "bloom" found on the fruit.

Mr. M. I. Nikitin of P.O. Box 165, Fairfield, Sydney N.S.W. would like someone, preferably from the North of Australia, to correspond with him on the subjects of butterflies and dragonflies.

Anyone wishing for further copies of this Special Feature journal, may obtain same for the price of 5/-. Send to Secretary, Box 991, Cairns.

—o—

POT POURRI.

A DEADLY MEAL.

A Kookaburra tried to make a meal of a green tree snake. However, after swallowing all but a foot of it, the bird died. No winners in this match.

—o—

RED BACKED SPIDERS.

It is now thought that our Red Backed Spiders are the same species as The Black Widow of America and have been renamed Lactrodectus mactans. A couple of these spiders plus three egg sacs were collected to send South for study. Before getting South, one sac hatched — about 500 little spiderlings and the owner, not thinking, took off the top of the bottle, to have small redbacks happily climbing all over the house. Let us hope he was able to deal with all of them, or his wife may not be too happy about it.

SPECIALIST ADVISORY PANEL

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