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# Development of the Sea Nettle *Chrysaora quinquecirrha* (Scyphozoa, Semaeostomeae)[1]

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**ABSTRACT: The development of *Chrysaora quinquecirrha* from the newly-liberated ephyra through the medusa stages is described. Studies on the development of specimens from nature were correlated with observations on laboratory-reared medusae. Growth was followed through six stages, successive stages being characterized by the appearance of or change in a given morphological character. Young ephyrae were similar to those of *C. melanaster*, having slender, pointed lappets and deeply cut ocular clefts. Medusae having one, three, five, and seven or more tentacles per octant were observed. The number of lappets increased following an increase in the number of tentacles. This confirms that the number of tentacles and lappets is unreliable as a criterion for generic distinction in the Pelagiidae.**

## Introduction

The venomous jellyfish *Chrysaora quinquecirrha* (Desor, 1848) is widely distributed in warm waters along the coasts of the Atlantic and Indian oceans, and along the western Pacific (Kramp, 1955). Along the East Coast of the United States it is common to abundant in certain areas from southern New England to the tropics. In the Chesapeake Bay region, *C. quinquecirrha* is abundant, particularly in meso- and polyhaline waters of the numerous creeks and rivers. In Virginia waters medusae usually appear during May and disappear in September, but occasionally they survive until November. Maximum abundance is usually attained during July and August, coinciding with the peak of the vacation season. Despite the abundance and significance of this organism as a pest in the Chesapeake Bay region and elsewhere, it has received relatively little study until recently.

The morphology of the medusa has been described by several authors, including Agassiz (1865), Agassiz and Mayer (1898), Mayer (1910), and Stiasny (1919). Ephyrae were illustrated by Mayer (1910) and Cones (1969), and by Littleford (1938, 1939), who briefly summarized their development to the post-ephyral stage.

This report outlines the development of *C. quinquecirrha* from the newly-liberated ephyra to the fully developed medusa stages, correlating laboratory studies with observations on natural populations.

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## Materials and Methods

Ephyrae used in laboratory culture were liberated from strobilae obtained in cultures of scyphistomae. The scyphistoma cultures were established 21 August 1969 by isolating planulae from medusae of *C. quinquecirrha* collected in Wilson Creek, Virginia.

On liberation, ephyrae were placed in watch glasses and fed nauplii of *Artemia*, strained *Mnemiopsis*, or both. After ingestion of food, ephyrae were placed in stoppered Erlenmeyer

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flasks containing one liter of filtered York River seawater of 20 o/oo salinity. Flasks were secured to a Burrell wrist-action shaker and agitated gently. Developing ephyrae and medusae were removed to finger bowls briefly each day and fed nauplii of *Artemia.* Cultures were maintained at room temperature, and water in the flasks was changed twice weekly. After reaching approximately 3.5 cm in diameter 35 days after liberation, medusae were transferred to an aquarium containing 12 liters of filtered York River seawater.

The development of laboratory-reared specimens was compared with various ephyra and medusa stages collected in nature at a number of locations (Table 1).

## Observations

Although the development of *Chrysaora quinquecirrha* from the ephyra to the fully developed medusa is gradual and continuous, six stages have been recognized here to simplify description of the process. Two of the stages trace the growth of the ephyra; the remainder outline the development of the medusa. Of 40 newly-liberated ephyrae reared in the laboratory, 17 reached early Stage IV within a month. Their development after this period was retarded and none reached sexual maturity, although medusae were kept alive in the laboratory for two months. The largest laboratory-reared medusa was a Stage IV specimen measuring 5 cm in diameter. Stage V and Stage VI medusae were observed only in nature.

Ephyrae were pinkish or reddish initially, but later were whitish or translucent. None of the laboratory-reared medusae developed the red or brown pigmentation occurring in some specimens of this species.

STAGE I (Fig. 1). Newly-liberated ephyra about 2.0-3.5 mm wide from lappet-tip to lappet-tip, margin typically with eight pairs of lappets and eight rhopalia, lappets slender, pointed distally, terminating in a cap of nematocysts. Rhopalar clefts deeply cut, reaching well over half-way along the ephyral arms, U- or V-shaped, wider near the lappet-tips than at the base. Manubrium short, quadrate, gastrovascular cavity with 16 broad radial pouches, gastric cirri undeveloped, their future location marked by four interradial spots, primary tentacles absent on their precursors present as faint projections at the base of each tentacular cleft. Mesoglea thin, exumbrella with scattered nematocyst batteries, including a prominent battery composed solely of holotrichous haplonemes at the base of each lappet.

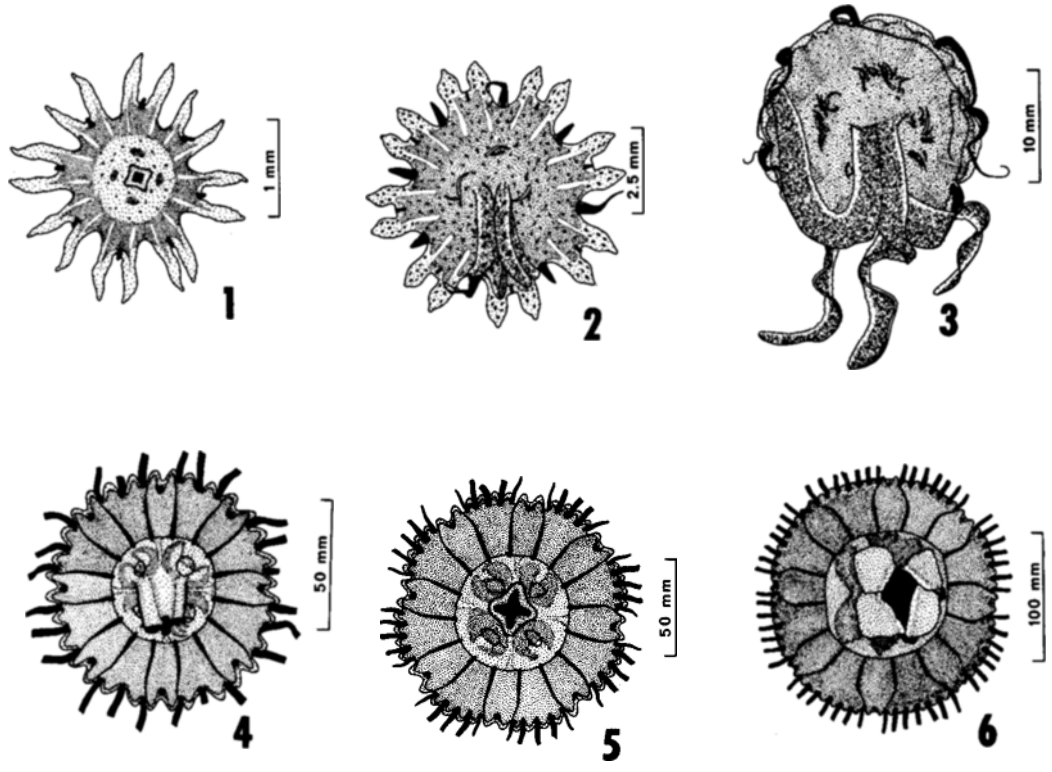
Remarks: Newly-liberated ephyrae from laboratory-reared strobilae were indistinguishable from those liberated from strobilae collected at West Point on the Corrotoman River, Virginia. The ephyrae were larger than those described by Littleford (1939) and much smaller than indicated in Cones' (1969) figures. However, specimens examined here corresponded in size with measurements of ephyrae given by Cargo and Schultz (1966).

Young ephyrae of *C. quinquecirrha* are similar to Kakinuma's (1967) description of *Dactylometra pacifica* (=*Chrysaora melanaster*) from Japan at a comparable stage.

STAGE II (Fig. 2). Ephyra with primary tentacles present, one oral arm developing at each perradial corner of the large manubrium. In advanced specimens, primary tentacles prominent, gastric cirri present interradially, one or more per quadrant, tentacular pouches of the gastrovascular cavity perceptibly broader distally than the rhopalar pouches. Lappets

TABLE 1. Collection data for jellyfish examined during this study.

| Location | Date Collected | Stages Observed |
|---|---|---|
| Corrotoman River, Va. | 14 May 1970 | I |
| Great Wicomico River, Va. | 27 May 1970 | II, III, IV |
| Ware River, Va. | 9 June 1970 | II, III, IV |
| Hillsborough Bay, Fla. | 17-18 July 1970 | III, IV, V |
| Old Tampa Bay, Fla. | 18 July 1970 | IV |
| Dunn's Creek, Fla. | 20 July 1970 | IV |
| West Bay, Pamlico Sound, N. C. | 22 July 1970 | IV, V |
| Broadkill River, Del. | 22 August 1970 | IV, V, VI |




Figs. 1-6. Stages in the development of *Chrysaora quinquecirrha*, subumbrellar view. Medusae are shown with lappets extended, tentacles cut off near the base, and oral arms removed in Figs. 4-6. 1. *Stage I.* Newly-liberated ephyra, from laboratory cultures. 2. *Stage II.* Ten-day-old laboratory-reared ephyra. 3. *Stage III.* Twenty-day-old laboratory-reared medusa. 4. *Stage IV.* Medusa from the Great Wicomico River, Virginia. 5. *Stage V.* Medusa from Hillsborough Bay, Florida. 6. *Stage VI.* Medusa from the Broadkill River, Delaware.

remaining pointed distally but distinctly broader, their lateral edges becoming folded downward. Oral arms more or less distinct, each capable of independent movement.

Remarks: This stage is characterized by the presence of the eight primary tentacles, appearing under laboratory conditions within one to three days after liberation. These tentacles appeared simultaneously and developed at the same rate, unlike those of *C. hysoscella* (Russell, 1970). During Stage II the gastric cirri appear, the primary tentacles develop considerably, and the lappets increase significantly in breadth.

STAGE III (Fig. 3). Lappets spade-shaped, distinctly concave on the subumbrellar surface and curved downward toward the subumbrella with the adrhopalar edges occasionally overlapping. Original lappet-tips, when evident, asymmetrically placed, being located nearer the rhopalar cleft than the tentacular cleft. Each lappet with a more or less distinct groove on the exumbrellar surface. Several well-developed gastric cirri per quadrant, manubrium relatively large, oral arms distinct, becoming crenulated in advanced specimens. Exumbrella with a depression developing adjacent to each rhopalium.

Remarks: With the folding under of the lappets, specimens lose the appearance of the ephyra. Under laboratory conditions this stage was reached within 10 to 14 days.

STAGE IV (Fig. 4). Secondary tentacles present between the primary tentacles and rhopalia, one arising from each corner of the tentacular pouches of the gastrovascular cavity. Notches appearing at the tip and near the base of the lappets adjacent to the secondary tentacles, each of the original 16 lappets thus becoming divided into two to form 32 lingueform lappets. Periphery of the exumbrella with 32 radial grooves, one pair, lateral to each of the eight rhopalia, extending outward along the rhopalar lappets, and a second pair lateral

to each of the eight primary tentacles, extending outward to the tentacular lappets, nematocyst batteries few or absent in these grooves. Exumbrellar depression adjacent to each rhopalium deeper, with few or no nematocyst batteries. Oral arms long and frilly. In advanced specimens, four subgenital pits present interradially, gonads becoming developed. Secondary tentacles well-developed.

Remarks: This stage is marked by the appearance of the secondary tentacles, attained in laboratory-reared specimens about 25 days after liberation. Medusae in the Chesapeake Bay region usually become sexually mature during this stage.

STAGE V (Fig. 5). Tertiary tentacles present lateral to the secondary tentacles, lappets adjacent to the tertiary tentacles becoming notched, then divided into two, the margin having a total of 48 lappets.

Remarks: With the development of the 16 tertiary tentacles and the clefting of the lappets adjacent to these tentacles, the medusa reaches the "*Dactylometra*" stage, having 40 tentacles and 48 lappets.

STAGE VI (Fig. 6). Medusa with seven or more tentacles and eight or more lappets per octant.

Remarks: Stage VI medusae were not observed in Chesapeake Bay during this study, but specimens with as many as nine tentacles and ten lappets per octant were collected in the Broadkill River, Delaware, on 22 August 1970.

## Discussion

The sea nettle was originally described as *Pelagia quinquecirrha* in a one paragraph report by E. Desor (Boston Society of Natural History, 1848). Agassiz (1862) removed the species to his new genus *Dactylometra*, distinguished from *Pelagia* in having (1) tentacular pouches of the gastrovascular cavity broader than, rather than equal in width to the rhopalar pouches; (2) 40 tentacles rather than 8; (3) 48 lappets rather than 16. *Dactylometra* was distinguished from *Chrysaora* in having (1) 5 rather than 3 tentacles per octant; (2) 48 rather than 32 lappets. Subsequently, Mayer (1910), Stiasny (1919), Kramp (1955) and others noted that specimens of *Dactylometra*, including *D. quinquecirrha*, pass through a *Chrysaora* stage in their development. Occasionally, Medusae of *D. quinquecirrha* become sexually mature in the *Chrysaora* stage and never attain the *Dactylometra* stage. Thus, the two genera are based merely on different developmental stages (Stiasny, 1939; Kramp, 1955), and Kramp is correct in synonymizing them, the name *Chrysaora* Péron and Lesueur, 1809 having priority over *Dactylometra* Agassiz, 1862. In the present study, specimens of *C. quinquecirrha* with as many as 7-9 tentacles and 8-10 lappets per octant were found in the Delaware Bay region. This confirms Kramp's (1955, 1961) conclusion that the genus *Kuragea* Kishinouye, 1902, established for specimens having 56 tentacles and 64 lappets, represents merely another stage in the development of *Chrysaora*, and cannot be recognized as a valid genus. Studies on the development of *Chrysaora* medusae thus demonstrate that the number of tentacles and lappets is variable and that neither is a reliable taxonomic character in this group of scyphozoans. With *Dactylometra* and *Kuragea* placed in synonymy, the number of genera belonging to the family Pelagiidae is reduced to three, *Pelagia, Chrysaora*, and *Sanderia* (Kramp, 1961).

Spangenberg (1965) noted that the age and size at which a particular morphological structure appears in *Aurelia aurita* varies considerably. Similarly, age and size were not regarded as reliable criteria upon which to base observations on the development of *Chrysaora quinquecirrha.* Consequently, Spangenberg's procedure of recognizing a number of stages of jellyfish development was followed here. However, such stages are artificial categories erected only to simplify description of the developmental process.

Abnormalities were occasionally observed in specimens of *C. quinquecirrha*, and individual variation in morphology was evident. Descriptions in this paper, however, have been based on "typical" specimens. Variability in color and in the pattern of pigmentation in this species has already been noted (Mayer, 1910; Kramp, 1955). Such differences were considered by Littleford (1938) to be of no taxonomic significance.

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