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NOTES ON THE LIFE HISTORY AND BEHAVIOR OF THE COMMUNAL SPIDER *CYRTOPHORA MOLUCCENSIS* (DOLESCHALL) (ARANEAE, ARANEIDAE) IN YAP, CAROLINE ISLANDS

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ABSTRACT

Cyrtophora moluccensis is a semi-social tropical spider that builds colonies that may contain hundreds of individuals of that species plus several other species. Studies in Yap were undertaken to determine the time required for development from egg to sexual maturity. The smaller instars were cage reared; and in the field, the larger instars were marked for observation. Although the duration of different instars is similar, there is considerable variation among individuals. Each instar lasts about 11 days. After emerging from the cocoon, males mature in about two months, and females in about four months. Mating occurs only near mid-day, and females may mate more than once. Each cocoon averages 1250 eggs, and nearly all the eggs hatch and emerge from the cocoon. The time between production of the cocoon and emergence of the young is about 25 days. Although one female produced seven cocoons, females typically produce three or four cocoons at 10-23 day intervals.

INTRODUCTION

Of the 30,000 known species of spiders, only about 33 show good evidence of group living (Burgess 1978). One of these species is *Cyrtophora moluccensis* (Doleschall), a semi-social spider found in the tropical Pacific, India, Malaysia and Southern Japan. The species is usually found in large colonies containing hundreds of individuals in all stages of the life cycle. The webs are most abundant in areas where the natural vegetation has been disturbed, such as gardens, near roadsides, or in scrub vegetation. In gardens the colonies may become large enough to be plant pests. Sometimes gasoline-soaked coconut fronds are thrown on them and burned. Colonies are present year-round, and in New Guinea one colony was known to have occupied the same site for 12 years (Lubin 1980). The communal webs have been illustrated by Lubin (1973, 1980) and Sabath, et al., (1974).

Relatively few spiders have been investigated to determine longevity and time to maturity. Levy (1970) determined the life cycle of *Thomisus onustus* and summarized the life cycles of 31 other species that have been studied. He noted that the duration of the developmental period has been shown to be wide range—from a quick developmental time where there are two generations per year in the lycosid *Pirata piraticus* to as much as ten years for attaining maturity in species of Theraphosids. In temperate zones, where spiders are limited by cold weather, some species overwinter as adults; but in many species, the spiderlings hatch in the fall and stay in the cocoon through the winter. Although there are reports of spiders living several years, most spiders in the temperate zone live only 12-18 months (Bonnet 1935). Compared to those in the temperate zones, the life-cycles of tropical spiders are not well-known. Robinson and Robinson (1973) found in New Guinea that adult and immature *Nephila maculata* (Fabricius) were present throughout the year but were more abundant during the wetter seasons. Egg laying occurred throughout the year. However, Thakur and Tembe (1956) found that *N. maculata* near Bombay is markedly seasonal. Lubin (1972) provided data on the life history of *Cyrtophora moluccensis* in New Guinea. The *Cyrtophora* web, a high cost, relatively inefficient trap for flying insects, has increased durability and strength with a low frequency of renewal (Lubin 1973, 1974). Sabath, et al., (1974) studied *C. moluccensis* on Guam and described the cocoon, number of eggs per cocoon, and the inquilines of the web. I will discuss here the length of time required to reach maturity, number of cocoons, interval between production of cocoons and other aspects of reproduction.

METHODS

Observations on *Cyrtophora moluccensis* (Doleschall) were made in the natural habitat from January 1980 to June 1980 on the island of Yap in the Caroline Islands. The Yap Islands lie in the western part of the Caroline Island group about 1000 km southwest of Guam, cover a total area of about 200 km^2, and were formed by land upheaval. The warmest and coolest months differ by only 1^0C in average temperature, with the daily maximum and minimum averaging 30^0 and 24^0C. Normal annual rainfall is over 300 cm: the drier season (December through April) averages 13-20 cm monthly, and the wetter season (May through November) averages 25-38 cm monthly. Relative humidity (RH) rarely falls below 75%. Daily observations of the spiders were made in the village of Fedor, where the communal webs were very abundant in and around the garden patches of taro (*Cyrtosperma chamissonis*). Largely because of the size of the communal web, it was not possible to rear the female spiders in an enclosure. This made it necessary to use several different methods of observation and measurement.

Early development.—Newly formed cocoons were removed from the web, opened, placed in stoppered glass vials that had a strip of paper to admit air inserted between the stopper and vial, and observed each day with a dissecting microscope.

Early instars.—Because there was no way to mark the early instars without damaging them, individuals had to be identified by location in the web. This was not entirely satisfactory because the early instars move from one location to another, even occasionally moving into another's orb-web and displacing the original habitant. Data on the early instars were collected in three ways: (1) direct observation in the field, (2) placing hatching cocoons in a screen enclosure (1 × 2 × 0.5 meters) in Yap, and (3) placing cocoons from Yap in screen enclosures in controlled temperature and humidity chambers (25-30^0C and 80% RH) in Indianapolis, Indiana. Because these young individuals usually would not build normal webs when alone in experimental chambers, it was necessary to have large numbers of them together. This made it difficult to be certain of the identity of a particular individual on successive days. *Drosophila melanogaster* colonies were satisfactory food sources for instars II and III but not for the later instars. No good food supply was found for the intermediate instars. *Drosophila* seemed too small for them, and the spiders were unable to capture larger dipterans.

Later instars.— All observations on the later female instars (instar V-X) were made in the field. Newly molted individuals could be recognized by their pale grey-green color which remained for about a day following ecdysis. Newly molted individuals were marked on a leg or the abdomen with a spot of model airplane paint which did not seem to interfere with their normal activity, and were observed each day in their natural habitat. Attempts to move individuals to start a new colony were not successful, largely because of the high predation by the very abundant skink populations (*Emoia callisticta* and *Emoia caeruleocauda*). When investigators tore down a communal web, several skinks appeared and quickly devoured all the displaced spiders.

RESULTS AND DISCUSSION

Colony size.—Although solitary individuals are occasionally found, the species characteristically lives in colonies composed of hundreds of individuals of *Cyrtophora moluccensis* and fewer numbers of several other species. All the members in one average size colony (about 15 m^2) were collected and identified: the colony contained 447 specimens of *Cyrtophora* and 236 specimens divided among six other species (Table 1). This averaged 30 *Cyrtophora* and 45 spiders of all species per m^2. One doughnut-shaped colony was 28 meters in circumference. Wheeler (1926), reporting that colonies of *Cyrtophora citricola* can be immense, described one colony of over 1000 ft^2.

Number and size of instars.—Because it was not possible to feed the larger instars properly, no females were reared in the laboratory from egg to maturity. From marked individuals in the field and the specimens kept in the laboratory, it was possible to determine the amount of time in each stage of development. By daily observations, some females were followed through three instars. Excluding the deutovum, the duration of the various instars was 6-22 days, with the mean being 11 days ($N = 59$). Although the time in each instar varied within instars and among instars, the overall picture shows a regular progression in development with no instars developing particularly fast or slow relative to the others. Other investigators who have reared spiders under controlled conditions have reported a problem with constancy in the number of developmental instars. Deevey (1949) found that *Lactrodectus mactans* females that were fed maximally matured at the seventh molt while those fed only every fourth day required 8-9 molts. Whitcomb, Hite and Eason (1966) found great variations in the number of instars in *Peucetia viridans* even when all spiderlings were reared under identical conditions. Miyashita (1968) noted that the number of instars in *Lycosa T-insignita* increased as the interval of food supply was prolonged. Conversely, Turnbull (1965) found that *Agelenopsis potteri* matured in seven instars regardless of the feeding rate. Robinson and Robinson (1978) concluded that the number of molts that spiders of the same sex undergo before maturity is variable, and that the greater the number of molts, the larger was the adult spider. Working with *Argiope argentata* and *A. aemula*, they found that the females had up to 15 instars, although some females matured at the thirteenth or fourteenth instar; and the males at either the seventh or eighth instar.

Table 1.—Number of specimens present in one average size colony of *Cyrtophora*. The longest dimensions of the web were 5 meters by 4 meters; the lowest point about 0.5 meter above the ground, the top about 1.0 meter high. Total surface area was 15 m^2 and the volume was 12.5 m^3. All specimens were taken from the same web on the same day (March 7, 1980).

Species	Male	Female	Immature	Total
Cyrtophora moluccensis	49	10	390	447
Argyrodes argentatus	4	40	136	217
Argyrodes sp. C	15	12	42	69
Argyrodes sp. D	19	17	14	50
Neoscona sp. D	—	—	1	1
Argiope appensa	—	—	1	1
			Total for colony—	785

Since limited field study made it impossible to determine the number of instars and, therefore, the total time to maturity for any single female, an analysis of the size classes of *Cyrtophora* from the censused colony (Table 1) was undertaken. Several studies have shown that determination of instar usually cannot be accomplished by carapace measurements (Edmunds 1982; Kaston 1970) because the size ranges of the different instars overlap. Measurements of the *Cyrtophora* carapace length and width indicated that there were distinct size classes, but they did not provide a clear separation of the various instars (Table 2). However, the total number of dorsal spines on both the left and right leg III, together with the length of leg I (patella through tarsus) did show a significant separation (Fig. 1). The other segments of leg I could not be measured without damage to the small specimens. Dorsal spines on both left and right leg III were counted because the number of spines on both legs was not consistent for many individuals. For example, the presumed instar VII never had more than two dorsal spines on leg III, but the count on 40 individuals showed left and right combinations of 2-2, 2-1, 2-0, and 1-2. The combination of 2-2 appeared in 33 of the 40 individuals examined. Although it is likely that some specimens have been incorrectly assigned to a certain instar, I feel confident that the separation by instar is generally accurate and that many females have 11 instars to reach maturity.

The first four instars could be distinguished by size with relative ease. Instars IV and V overlapped in size but most of the specimens were clearly of two different age groups. Some individuals of instars V and VI also overlapped in leg length ($\bar{x}$ = 3.40 mm and 4.79 mm, respectively), but all those specimens assigned to instar VI had at least one dorsal spine on leg III. It appears that they usually add a spine to leg III at each instar from instars VI-IX, but this is not always true. One specimen, assigned to instar VIII, had the same number of spines before and after molting. This probably explains the difference in number of spines on the left and right legs. Although this method of establishing the number of instars is inherently imprecise, it does provide a reasonable estimate of the number of instars in this colonial species. The variation in the number of instars cannot be determined from the data available.

Two males were reared successfully in the laboratory: the times from hatching to sexual maturity were 56 days and 66 days. The number of instars could not be accurately determined, and both specimens died while completing the last ecdysis.

Analysis of male specimens from the censused web indicated that there were six instars to sexual maturity. Several investigators have noted that there is a

Table 2.—Measurements of carapace, number of dorsal leg spines of leg III and leg length for the different instars.

	Carapace width (mm)	Carapace length (mm)	No. of Leg III dorsal spines			Patella—tarsus length (mm)	
			Left	Right	Total	Leg I	Leg IV
Instar I (deutovum); $N = 5$							
Mean	0.47	0.6	0	0	0	0.76	0.75
Range	0.4-0.5	0.0				0.76-0.78	0.75-0.76
SD	0.04	—				0.01	0.01
Instar II; $N = 11$							
Mean	0.52	0.67	0	0	0	1.22	1.09
Range	0.50-0.53	0.60-0.70				1.13-1.30	1.03-1.13
SD	0.01	0.03				0.05	0.04
Instar III; $N = 14$							
Mean	0.62	0.81	0	0	0	1.78	1.49
Range	0.58-0.70	0.71-0.90				1.63-1.96	1.46-1.66
SD	0.03	0.05				0.09	0.16
Instar IV; $N = 24$							
Mean	0.74	0.99	0	0	0	2.5	2.1
Range	0.7-0.8	0.8-1.1				2.2-2.7	1.8-2.2
SD	0.04	0.06				0.1	0.1
Instar V; $N = 36$							
Mean	0.94	1.22	0	0	0	3.40	2.77
Range	0.8-1.2	1.0-1.5				2.7-4.6	2.1-3.7
SD	0.09	0.10				0.37	0.31
Instar VI; $N = 40$							
Mean	1.23	1.66	0.93	0.93	1.85	4.79	3.82
Range	0.90-1.45	1.25-1.90	0-1	0-1	1-2	3.4-5.9	2.9-4.7
SD	0.12	0.15	0.26	0.26	0.35	0.48	0.36
Instar VII; $N = 40$							
Mean	1.69	2.29	1.95	1.8	3.8	6.79	5.50
Range	1.4-2.0	1.9-2.9	1-2	0-2	2-4	5.0-9.0	4.2-7.1
SD	0.18	0.25	0.22	0.56	0.49	0.85	0.73
Instar VIII; $N = 37$							
Mean	2.3	3.0	2.8	2.9	5.6	9.1	7.4
Range	1.8-3.0	2.3-3.4	2-4	2-4	5-7	7.3-11.7	5.9-8.9
SD	0.25	0.29	0.6	0.6	0.7	1.0	0.9
Instar IX; $N = 32$							
Mean	3.0	4.0	4.2	4.0	8.2	12.5	10.3
Range	2.1-3.9	3.2-4.9	3-5	3-5	7-10	9.8-15.6	8.0-12.4
SD	0.4	0.4	0.5	0.5	0.8	1.4	1.3
Instar X; $N = 10$							
Mean	4.8	6.3	6.2	6.0	12.2	19.0	16.4
Range	4.2-5.2	5.8-7.2	5-7	5-7	11-14	16.7-20.9	14.6-17.7
SD	0.3	0.4	0.6	0.6	0.9	1.4	1.0
Instar XI; $N = 8$							
Mean	6.5	7.9	6.2	7.1	13.3	24.5	20.7
Range	6.1-7.2	6.8-8.5	6-7	6-9	12-16	22.7-26.2	18.8-22.9
SD	0.3	0.6	0.4	1.0	1.2	1.1	1.2

tendency for the males of species with strong sexual size dimorphism to mature in fewer instars than the females (Levy 1970; Robinson and Robinson 1976, 1978). The sex of instars I (deutovum) and II could not be determined but at instar III the pedipalps of the males have a greater diameter than do the pedipalps of the females (male $\bar{x} = 0.10$ mm, SD = 0.01, $N = 10$; and female, $\bar{x} = 0.07$ mm, SD =

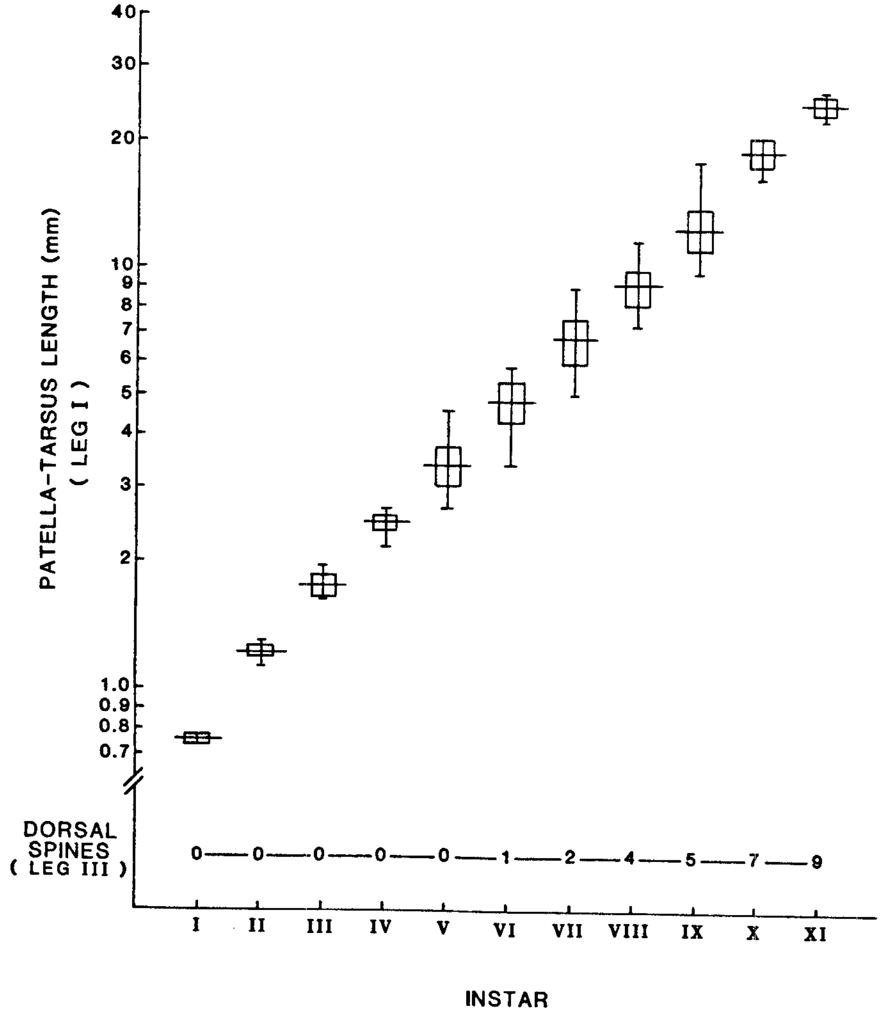

Fig. 1.—Comparison of the various size classes of *Cyrtophora moluccensis* females based on length of leg I and the number of dorsal spines on leg III. The vertical line represents the range, the horizontal line represents the mean, and the box indicates one standard deviation above and below the mean. The dorsal spine count indicates the maximum number of dorsal spines on either the left or right leg III.

0.003, N = 11). The male instar IV pedipalp tarsi are more enlarged ($\bar{x}$ = 0.18 mm, SD = 0.02, N = 14), being about three times the diameter of their leg I tarsi ($\bar{x}$ = 0.07 mm; SD = 0.003). At instar V the specimens are subadult, with greatly enlarged pedipalps ($\bar{x}$ = 0.57 mm, SD = 0.02, N = 12). Instar VI (49 specimens) were mature males. The carapace width of mature females was almost five times that of mature males (females = 6.5 mm, SD = 0.3; males = 1.3 mm, SD = 0.06).

Age at maturity.—Assuming that the female *C. moluccensis* has 11 instars, it is possible to estimate the age at maturity. Table 3 gives the times of embryonic development and the duration of each instar as determined in the laboratory and in the field. From the time the egg is laid until the female reaches sexual maturity is about four months. Adding the mean time spent in the cocoon (25.4 days) to the 56 and 66 days required for laboratory *C. moluccensis* males to reach

Table 3.—Length of time (days) for each developmental stage of immature females. Lab numbers for the egg indicate days until egg hatches to deutovum. Numbers for field conditions indicate time interval between when the egg was laid and when the instar II spiderlings emerge from the cocoon. Instar I (deutovum) data are from 11 cocoons, representing thousands of hatchlings.

	INSTAR										
	EGG	I	II	III	IV	V	VI	VII	VIII	IX	X
LAB											
Range	9-13	0	9-12	9-14	7-20	8-12	—				
Mean	11.8	3.5	10.5	13.2	13.2	10	20				
SD	1.3	0.7	1.7	1.8	4.6	1.6	0				
N	11	11	4	6	4	3	1				
FIELD											
Range	(←— 24-28 —→)					8-13	8-14	9-11	8-12	10-16	13-17
Mean	25.4					10.5	12.0	9.2	10.1	13.3	15.2
SD	1.5					2.5	2.2	1.8	1.4	1.9	1.6
N	8	0	0	0	0	2	5	5	12	13	15
ALL											
Mean						10.2	13.3	9.2	10.1	13.3	15.2
SD						2.0	3.6	1.8	1.4	1.9	1.6

maturity yields a value for males from egg to sexual maturity of about three months. Many spiders were followed through the five months of field study, but most of them died or disappeared during the period of observation. This agrees with Lubin (1980) who calculated that the adult female life span was about 3.5 months. Since it appears that the adults of this tropical araneid survive for about one-half year or less, in this respect they do not differ greatly from araneids of the temperature zones. Buskirk (1975) noted that the tropical araneid *Metabus gravidus* (Cambridge) became mature after five-seven months and that very few individuals survive longer than a year. Levy (1980) proposed two categories for spider life cycles: those in which both sexes undergo the same number of molts and mature at approximately the same time, and those where the male has fewer molts and completes his life cycle in a much shorter time than the female. Clearly, *Cyrtophora moluccensis* falls into this second category. Mating between spiders from the same cocoon is unlikely. This makes it necessary for males to mate with females from earlier cocoons, a situation usually possible only in the tropics. Reliable local informants in Yap indicated that the spiders are abundant throughout the year, as they are in New Guinea (Lubin 1980).

Mating.—Although the spiders were observed both day and night, no mating activity was seen earlier than 1100 hours nor later than 1400 hours. Of the 15 different matings seen, the median starting time was 1203 hours and the duration of courtship was 5-90 minutes. On one occasion, 21 males were active around a single female, but only two or three of them attempted to copulate. Usually only one male courted each female. Lubin (1980) reported that males spent more time on the webs of adult females that had just reached maturity than on webs of either last instar females or adult females that had already produced a cocoon, suggesting that females are most attractive during the period just after maturation and before laying the first egg.

Males usually live in a small orb built in the tangle of silk above or near the female's horizontal orb. The first evidence of mating seen is when a male leaves the tangle and moves toward the female's orb-web, entering around the outside edge or through the orb's mesh and moving onto the lower surface. The male then advances toward the female which is normally in the center of her orb. After a short time (seconds to minutes) of walking about on the underside of the web, he attaches a mating thread (see Robinson and Robinson 1980) which is about 8-10 cm long to the orb and climbs on it. Holding on with legs II and IV, he moves his legs I dorsally until they are below his cephalothorax. He then begins rapidly vibrating the thread with legs III. Blanke (1972) observed similar mating behavior in *Cyrtophora citricola* and determined that the strumming rate was not constant but varied from 10-18 strokes per second. In *C. moluccensis* "strumming" may continue as long as 30-40 seconds. If the female doesn't respond he may move to another position, construct another mating thread, and begin vibrating the new thread. Up to this point the spiders have not touched each other. The female may respond by turning toward him, holding onto the web with her legs III and IV, and make a "beckoning" motion with her legs I and II, and sometimes her legs III. Sometimes the female's legs III touch each other midventrally. If the female responds to the male, he may drop (with a drag line) onto the female, copulate, remain in the mating position for perhaps 10 seconds and then rapidly drop away and land a few cm below her on his dragline. He then leaves the orb and returns to the tangle above the web. Occasionally the female will hold the male in position with her legs III; and after mating, she may wrap him in silk and eat him. On two occasions a female wrapped the male in silk and then threw him to the ground. One of these males was recovered; and after the silk was removed, he then scurried away apparently unharmed. The outcomes of 15 attempted matings were as follows: the male mated and was eaten (5); mated and escaped (4); mated and was thrown to the ground (1); did not copulate but was thrown to the ground (1); or female did not respond to male (4). The movements of the male appeared to be similar to those described by Blanke (1972) and by Robinson and Robinson (1980) for other species of *Cytrophora.*

Egg production.—*Cyrtophora moluccensis* females may mate several times before producing a cocoon. During a 6-day period one female responded several times to a male's courtship behavior, but only on day one of this period did mating appear to be successful. At that time she mated with two males. On day four a male attempted three times to mate with her, but each time he probably was not in the mating position long enough to copulate, although the female seemed receptive. On day five, a male attempted to copulate, and the female responded to his vibration of the mating thread (see Robinson and Robinson 1980); but each time the male dropped away from the female without mating. On day six a male again vibrated a mating thread three separate times, but the female did not respond. On the night following day six, she produced a cocoon.

The time interval between mating and production of a cocoon was observed in five females. The mean time between observed mating and the appearance of a cocoon was 4.4 days (range = 2-8; SD = 2.0), but there was no way to ascertain that the mating observed was the only source of the sperm that fertilized the eggs that were subsequently produced. Lubin (1972) observed one female for which the time between copulation and production of the cocoon was 15 days, but the present study indicated that the time period is somewhat shorter. Although *C. moluccensis* females add cocoons one below another in a string with the newest one at the bottom, the cocoons in a given string may not all be produced by the same female. At night the females frequently roam about through the communal

Table 4.—Time interval between production of successive cocoons for three *Cyrtophora* females.

	Interval (days) Between Successive Cocoons						
	#1-2	#2-3	#3-4	#4-5	#5-6	#6-7	Median Interval
Female A	11	12	14	18	12	25	15.3
Female B	18	22	13	—	—	—	17.6
Female C	17	14	18	—	—	—	16.3
Mean	15.3	16	15	18	12	25	
Range	11-18	12-22	13-18				
SD	3.1	4.3	2.2				

web, displace other females, and may or may not return to their original orb. On one occasion, two marked females, each having made a cocoon that later produced live spiderlings, switched orbs. Several days later each female produced a second cocoon which was attached to the first cocoon produced by the other female. On another occasion, a female moved her cocoon from its original location to another orb at least two meters away. Subrahmanyam (1968) reported that the cocoons suspended in the dome of *C. cicatrosa* did not all belong to the same spider, and only the lowest one was the property of the spider living in the web. Since this phenomenon has now been reported for two species of *Cyrtophora*, perhaps more studies with marked females will show that this practice is widespread.

Six females were observed daily from the time they produced one cocoon until they produced another cocoon. Of these, two were followed from the beginning of their maturity until they had produced their second cocoon. The mean time between first and second cocoons was 14.6 days (range = 10-23; SD = 4.2). One marked female was followed through the production of seven cocoons before she died: the mean time between successive cocoons was 15.3 days (Table 4). Lubin (1980) found that in New Guinea the average interval between successive cocoons was 27.0 days, almost twice the average time found for the Yap females. Whether this difference is environmental or genetic is not known.

Production of the cocoon began at about 2200-2400 hours and usually took about four hours. The female first formed in the center of her orb an inverted shallow disc of silk (in the shape of a "Frisbee"), filled it with eggs, and then covered it with silk, first with white silk and then with green silk. The cocoon was then cut free from the orb and attached by a silk "stalk" to the network of threads of the dense snare web above the orb. The female remained with the cocoon, usually with her legs III and IV touching it, until it hatched or until another cocoon was added below the first one.

On Guam, Sabath et al. (1974) found that two cocoons contained 1400 and 1850 developing eggs. A count of 11 cocoons from Yap showed a mean number of 1250 eggs per clutch (range 846-1834). In New Guinea, Lubin (1980) found cocoons containing 877 ± 299 eggs. As with the average time interval between successive cocoons, these differences in number of eggs per cocoon could result from either environmental or genetic causes. Although I made no detailed study of the number of eggs in sequential cocoons from the same female, later cocoons, appeared to contain as many eggs as earlier cocoons. In undamaged cocoons, virtually 100% of the eggs hatched, completed the molting from deutovum to instar II, and the spiderlings left the cocoon.

Hatching.—The eggs from the 11 opened cocoons in glass vials hatched into the deutovum in 9-13 days (Table 3). At this instar, lasting 3-5 days ($\bar{x}$ = 3.5, SD = 0.7, N = 11), the spiderlings have no functional mouthparts or setae. The deutovum (instar I) molts into the characteristic spider form, instar II. Under field conditions the mean time from egg laying to emergence from the cocoon was 25.4 days (range = 24-28; N = 8). This means the spiderlings had been at instar II for about 10 days when they left the cocoon. Only once were spiderlings observed leaving an undisturbed cocoon. At 1345 hours they were exiting, one after another, through a small rent in the cocoon.

"Nursery web".—After leaving the cocoon, the spiderlings form a tangle of threads or "nursery web" approximately 0.5 meters above the ground and remain there for an average of six days (field = 4-6, N = 7; lab = 5-7, N = 4). They do not capture prey while in the nursery web. These tangled webs are known for many species of spiders, but little has been written about their possible function. Gertsch (1949) shows a cluster of spiderling orb weavers preparing to disperse. In a controlled environment room at high humidity, the spiderlings had a very high mortality unless misted daily with an atomizer, yet in the natural environment they survive without either rain or dew. In the laboratory they were seen to move toward and drink small droplets of water caught in the tangled threads of the nursery web.

When disturbed these spiderlings exhibited a synchronous twitching activity which was observed both in the field and in the laboratory. It appeared that a large percentage of the individuals in the web plucked simultaneously at the web at intervals of about 1-5 seconds and continued for up to 12 seconds. Further studies on the behavioral ecology of spiderlings in the nursery web would be valuable. In view of the report by Smith and Mommsen (1984) of pollen feeding in spiderlings, it would be worth investigating the possible function of the nursery web as a pollen collecting structure.

After leaving the nursery web, the spiderlings move up into the communal web and build their own dome-shaped orbs within the tangle of threads supporting the orbs of the larger individuals. Again, only once was an undisturbed cluster of spiders seen leaving a nursery web. At 1930 hours the nursery web seemed to be full, but a few individuals were seen moving out of the nursery web and into the communal web above. By 2145 hours the nursery web was nearly empty, and small spiders were seen attached to twigs and threads of the communal web. The next day there was a noticable increase in the number of small orbs, each about 6 cm in diameter, around the large female web (about 1 meter in diameter) above the former nursery web. Although I observed no ballooning in *C. moluccensis*, Blanke (1972) found *C. citricola* spiderlings over 100 meters from the nearest colony, indicating that ballooning may have occurred.

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LITERATURE CITED

Blanke, R. 1972. Untersuchungen zur Ökophysiologie und Ökethologie von *Cyrtophora citricola* Forskål (Araneae, Araneidae) in Andalusien. Forma et Functio, 5:125-206.

Bonnet, P. 1935. La longévité chez les Araignées. Bull. Soc. Entomol. France, XL:272-277.

Burgess, J. W. 1978. Social behavior in group-living spider species. Symp. Zool. Soc. London, 42:69-78.

Buskirk, R. E. 1975. Coloniality, activity patterns and feeding in a tropical orb-weaving spider. Ecology, 56:1314-1328.

Deevey, G. B. 1949. The developmental history of *Lactrodectus mactans* (Fabr.) at different rates of feeding. American Midl. Nat., 42:189-219.

Edmunds, J. 1982. The number of instars occurring during the development of *Argiope flavipalpis* and *Agriope trifasciata* (Araneae: Araneidae) in Ghana, West Africa. Bull. British Arachnol. Soc., 5(7):294-303.

Gertsch, W. 1949. American Spiders. Van Nostrand Co. New York. Plate 8.

Kaston, B. J. 1970. Comparative biology of American black widow spiders. Trans. San Diego Soc. Nat. Hist., 16(3):33-82.

Levy, G. 1970. The life cycle of *Thomisus onustus* (Thomisidae: Araneae) and outlines for the classification of the life histories of spiders. J. Zool., London, 160:523-536.

Lubin, Y. D. 1972. Behavioral ecology of tropical tent-spiders of the genus *Cyrtophora* (Araneae: Araneidae), Ph.D. Thesis. Univ. Florida. 163 pp.

Lubin, Y. D. 1973. Web structure and function: the non-adhesive orb-web of *Cyrtophora moluccensis* (Doleschall) (Araneae: Araneidae). Forma et Functio, 6:337-358.

Lubin, Y. D. 1974. Adaptive advantages and the evolution of colony formation in *Cyrtophora* (Araneae: Araneidae). Zool. J. Linnean Soc., 54:321-339.

Lubin, Y. D. 1980. Population studies of two colonial orb-weaving spiders. Zool. J. Linnean Soc., 70:265-287.

Miyashita, K. 1968. Growth and development of *Lycosa T-insignita* Boes, et Str. (Araneae: Lycosidae) under different feeding conditions. Appl. Entomol. Zool. (Japan), 3:81-88.

Robinson, B., and M. H. Robinson. 1978. Developmental studies of *Argiope argentata* (Fabricius) and *Argiope aemula* (Walckenaer). *In* Arachnology. (P. Merrett, ed.). Seventh Int. Cong., Symp. Zool. Soc. London, 42:31-40. London, Academic Press.

Robinson, M. H., and B. Robinson. 1973. Ecology and behavior of the giant wood spider *Nephila maculata* (Fabricius) in New Guniea. Smithsonian Contrib. Zool. No. 149. 76 pp.

Robinson, M. H., and B. Robinson. 1976. The ecology and behavior of *Nephila maculata*: a supplement. Smithsonian Contrib. Zool. No. 218. 22 pp.

Robinson, M. H., and B. Robinson. 1980. Comparative studies of the courtship and mating behavior of tropical araneid spiders. Pacific Insects Monogr. 36. Bishop Museum. 218 pp.

Sabath, M. D., L. Sabath and A. Moore. 1974. Web, reproduction, and commensals of the semisocial spider *Cyrtophora moluccensis* (Araneae: Araneidae) on Guam, Mariana Islands. Micronesica, 10(1):51-55.

Smith, R. B., and T. P. Mommsen. 1984. Pollen feeding in an orb-weaving spider. Science, 226:1330-1332.

Subrahmanyam, T. V. 1968. An introduction to the study of Indian spiders. J. Bombay Nat. Hist. Soc., 65:726-743.

Thakur, M. K., and V. B. Tembe. 1956. Bionomics of the giant wood spider, *Nephila maculata* Fabricius. J. Bombay Nat. Hist. Soc., 53:330-334.

Turnbull, A. L. 1965. Effects of prey abundance on the development of the spider *Agelenopsis potteri* (Blackwall). (Araneae: Agelenidae). Canadian Entomol., 97:141-147.

Wheeler, W. M. 1926. Social habits of some Canary Island spiders. Psyche, 33:29-31.

Whitcomb, W., M. Hite, and R. Eason. 1966. Life history of the green lynx spider, *Peucetia viridans* (Araneida: Oxyopidae) J. Kansas Entomol. Soc., 39:259-267.

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